SOLVING AMBIVALENCE IN CONTEXT

The experience and resolution of attitudinal ambivalence

Hannah U. Nohlen
SOLVING AMBIVALENCE IN CONTEXT

The experience and resolution of attitudinal ambivalence

Hannah U. Nohlen
SOLVING AMBIVALENCE IN CONTEXT
The experience and resolution of attitudinal ambivalence

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. D.C. van den Boom
ten overstaan van een door het College voor Promoties ingestelde commissie,
in het openbaar te verdedigen in de Agnietenkapel
op vrijdag 30 oktober 2015, te 14.00 uur
door Hannah Ulrike Nohlen
geboren te Essen, Duitsland
**Promotiecommissie:**

<table>
<thead>
<tr>
<th>Rol</th>
<th>Naam</th>
<th>Universiteit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotor</td>
<td>Prof. dr. A. H. Fischer</td>
<td>Universiteit van Amsterdam</td>
</tr>
<tr>
<td>Copromotores</td>
<td>Dr. F. van Harreveld</td>
<td>Universiteit van Amsterdam</td>
</tr>
<tr>
<td></td>
<td>Dr. M. Rotteveel</td>
<td>Universiteit van Amsterdam</td>
</tr>
<tr>
<td>Overige leden</td>
<td>Prof. dr. E. A. Crone</td>
<td>Universiteit Leiden</td>
</tr>
<tr>
<td></td>
<td>Dr. W. A. Cunningham</td>
<td>University of Toronto</td>
</tr>
<tr>
<td></td>
<td>Prof. dr. A. Dijksterhuis</td>
<td>Radboud Universiteit Nijmegen</td>
</tr>
<tr>
<td></td>
<td>Prof. dr. R. W. Holland</td>
<td>Universiteit van Amsterdam</td>
</tr>
<tr>
<td></td>
<td>Prof. dr. G. A. van Kleef</td>
<td>Universiteit van Amsterdam</td>
</tr>
</tbody>
</table>

Faculteit der Maatschappij- en Gedragswetenschappen
## Contents

**Chapter 1:** General Introduction 7

**Chapter 2:** Evaluating ambivalence:  
Neural correlates of ambivalent decision-making. 25

**Chapter 3:** On the affective nature of ambivalence:  
A facial EMG study on the role of choice and evaluative context in shaping affective responses to ambivalence. 45

**Chapter 4:** Resolving ambivalence in context:  
Neural responses to ambivalent information are also shaped by evaluative context. 71

**Chapter 5:** A waste of time?  
The prevalence and effectiveness of choice delay in ambivalent decision-making. 93

**Chapter 6:** General Discussion 121

References 137

English summary 152

Nederlandse samenvatting 157

Contributions to empirical chapters 163

Acknowledgement 165
Chapter 1
General introduction
Humans can evaluate effortlessly, and evaluations help us behave appropriately in a given situation: we generally approach and explore positively evaluated stimuli and avoid or attack negatively evaluated ones (Chen & Bargh, 1999, but see Rotteveel et al., in press; Darwin, 1872). Often, though, evaluations are not that straightforward and we have to deal with contradictory information that makes us evaluate a stimulus positively and negatively at the same time: We are for and against higher taxes, we like and dislike thunderstorms (depending on your plans for the day), and we feel happy and sad reminiscing about good, but past times. This simultaneous existence of positive and negative associations with a stimulus (i.e. a person, object, topic, group, or event) has been labeled ambivalence (Kaplan, 1972; Katz & Hass, 1988; Thompson, Zanna, & Griffin, 1995).

Ambivalence has been investigated since the early 20th century (Riklin, 1911). While early research focused mostly on what ambivalence is and how it should be defined (e.g., Bleuler, 1911; de Liver, van der Plig̈t, & Wigboldus, 2007; Kaplan, 1972; Priester & Petty, 1996; Thompson et al., 1995), later research focused more on the consequences of ambivalence for the individual. Based on the assumption that ambivalence elicits negative affect as it violates a fundamental human motive to be consistent in thoughts, feelings, and behavior (Briñol & Petty, 2005; Festinger, 1957; Newby-Clark, McGregor, & Zanna, 2002; Proulx, Inzlicht, & Harmon-Jones, 2012), considerable attention was devoted to how people cope with ambivalence (for an overview, see van Harreveld, van der Plig̈t, & de Liver, 2009; van Harreveld, Nohlen, & Schneider, 2015). Yet, much remains unknown about whether and under which circumstances ambivalence actually elicits negative affect, why individuals experience ambivalence about the same attitude object under some, but not other circumstances, and how individuals respond when confronted with having to make a choice about an ambivalent subject. By combining physiological (fMRI, facial EMG), self-report, and behavioral methods in as well as outside of the lab, I aim to contribute to answering these questions.
Defining ambivalence

The psychiatrist Paul Eugen Bleuler first introduced the term *ambivalence* at a Swiss conference in 1910 (Riklin, 1911). He identified ambivalence as one of the symptoms of schizophrenia by suggesting that individuals suffering from schizophrenia are more likely to allow positivity and negativity to co-exist. This, he proposed, was contrary to healthy adults, whom he assumed more likely to try to reconcile and resolve ambivalence instead of letting conflicting evaluations exist at the same time. The introduction of the term ambivalence into psychology and psychiatry was well received by the scientific community. In a response to Bleuler’s presentation, Carl Gustav Jung, for instance, predicted that the term ambivalence “will probably be an enrichment to the field” (p. 267, Riklin, 1911). Soon, use of the term ambivalence spread and it was applied in other contexts such as that of psychoanalysis (e.g., Freud, 1926). Yet, definitions of ambivalence remained relatively vague.

Over the years, the definition of ambivalence has evolved and the term ambivalence made its way into social psychology. Interestingly, the suggestion that individuals are inherently motivated to resolve ambivalence is an idea that has persisted until today (cf., van Harreveld, van der Pligt et al., 2009). Nowadays, ambivalence is defined as an evaluative conflict on the valence dimension. Within the concept of ambivalence, we differentiate between *structural ambivalence* and the *experience of ambivalence* (cf. Jonas, Broemer, & Diehl, 2000; Priester & Petty, 1996; Thompson et al., 1995; van Harreveld, van der Pligt et al., 2009). *Structural ambivalence* refers to an ambivalent attitude structure, thus the positive and negative associations an individual has with a particular stimulus. Structural ambivalence can (but does not have to) result in an acute state of experienced conflict, referred to as *experienced ambivalence*, which develops when competing stimulus associations are simultaneously active and cannot easily be resolved (cf. van Harreveld et al., 2015). Ambivalence can result in affective and behavioral changes, influence information processing as well as decision outcomes. Notably, these effects are often driven by individuals’ experienced ambivalence, thus believed to be the ‘gold standard’ of ambivalence research (DeMarree,

---

1 Note that the term *structural* does not imply that these associations are fixed, structural ambivalence toward a stimulus can change over time (cf. de Liver, 2007).
Wheeler, Briñol, & Petty, 2014; Thompson et al., 1995). Experiencing ambivalence has, for example, been shown to predict relapse in smokers (Menninga, Dijkstra, & Gebhardt, 2011), has been related to negative mood (Hass, Katz, Rizzo, Bailey, & Moore, 1992), is thought to create instability in the evaluation of political candidates (Lavine, 2001), and has been related to decreased customer loyalty (Olsen, Wilcox, & Olsson, 2005).

Measuring ambivalence

Ambivalence is usually assessed with self-report scales but until now the best way of measuring ambivalence remains a debate. A comprehensive overview of different methods has been published by Conner and Sparks (2002), who make a distinction between two trends in measuring ambivalence, one that they refer to as indirect measures, and one described as direct measures (see also Jonas et al., 2000).

Indirect measures consist of individuals’ self-reported positivity and negativity toward an attitude object as assessed by two separate scales (i.e. How positively do you evaluate X/ How negatively do you evaluate X?; Kaplan, 1972). These ratings are subsequently integrated using one of several formulas. The most common one has been developed by Thompson and colleagues’ (1995) and aims to capture the similarity and extremity of opposing evaluations: \[ \text{Ambivalence} = \frac{\text{PositiveRating} + \text{NegativeRating}}{2} - |\text{PositiveRating} - \text{NegativeRating}|. \] The higher the score on this measure, the more ambivalent are the evaluations of the stimulus. Conner and Sparks (2002) refer to such a formula-based approach as indirect, because individuals may not be aware of a conflict between evaluations and assessing ambivalence with two separate scales may reveal even such ambivalence individuals are unaware of in a given situation (see also Jonas et al., 2000). Consequently these measures are usually referred to as potential or objective ambivalence measures (Armitage & Arden, 2007; DeMarree et al., 2014).

Direct measures assess the degree to which individuals experience ambivalence. The two most well-known measures that fall into the category of direct measures of ambivalence are Jamieson’s felt ambivalence scale (1993) and Priester and Petty’s subjective ambivalence scale (1996). Jamieson’s scale assesses how torn and conflicted individuals feel about the attitude object and the scale has often been suggested to assess the affective side of ambivalence (e.g., Berndsen & van der Pligt, 2004). Priester and Petty’s scale consists of
three items assessing individuals’ mixed reactions, felt conflict, and indecision with regard to an attitude object. Scores on both scales are averaged to compute an overall felt or subjective ambivalence score, respectively.

Supported by the fact that direct and indirect measures have been shown to correlate only weakly (r = .18; Newby-Clark, McGregor, & Zanna, 2002), it has been suggested that indirect measures assess solely structural ambivalence and direct measures assess only experienced ambivalence. However, it remains unclear whether indirect measures indeed measure structural properties of the attitude that are not, or not as adequately, assessed by direct measures. In general, Priester and Petty’s subjective ambivalence scale is most widely used in research on ambivalence. In order to be consistent across studies, I will also rely on Priester and Petty’s subjective ambivalence scale to determine ambivalence in this dissertation.

Similar, but distinguishable constructs

Several constructs are related to, and sometimes confused with, ambivalence. In order to provide clarity about what is meant with ambivalence, four more prominent, related constructs and their differences with ambivalence need to be discussed: inconsistency, cognitive dissonance, ambiguity and uncertainty.

In his original theory on cognitive dissonance, Festinger suggests that “the existence of nonfitting relations among cognitions” leads to an aversive feeling, with cognitions referring to “any knowledge, opinion or belief about the environment, about oneself, or about one’s behavior” (p. 3; Festinger, 1957). This description of cognitive dissonance consists of two elements, inconsistency between cognitions on the one hand, and aversive feelings on the other. Whereas Festinger uses the term cognitive dissonance interchangeably for the mismatch between cognitions and the affective consequence of this mismatch (i.e. aversive feelings), for clarity reasons, others have suggested to refer to a mismatch between ‘cognitions’ as an inconsistency and reserve the term cognitive dissonance for the aversive feeling that is elicited by such an inconsistency (Gawronski, Peters, & Strack, 2008). Two cognitions, x and y, are inconsistent “if not-x follows from y” (Festinger, 1957, p. 13). For example, the propositions ‘Peter dislikes cats’ and ‘Peter has a cat’ would be inconsistent, because they refer to the same subject-object relation (Peter and cats), and are in conflict with each other (he dislikes cats, yet he owns a cat). Inconsistencies and dissonance are often studied in the context of induced
compliance paradigms, in which participants are motivated to behave against their own attitude by receiving either a small or large reward (Festinger & Carlsmith, 1959). Even though inconsistency generally refers to two or more beliefs that contradict each other, it is most commonly understood in terms of these induced compliance paradigms, and thought to reflect a mismatch between attitude and behavior. In their classic experiment, Festinger and Carlsmith found, for instance, that participants were more positive about a very tedious and boring task if they were given $1 for telling another (confederate) participant that the task was enjoyable compared to when they were given $20. This shift toward an attitude that is more in line with the displayed behavior has been ascribed to the motivation to reduce cognitive dissonance.

The relatively broad definition of inconsistency as an informational conflict encompasses many phenomena, one of these is ambivalence (for reviews, see Gawronski and Strack, 2012). In the case of ambivalence the informational conflict is always on the valence dimension (positive vs. negative; van Harreveld, van der Pligt, et al, 2009), which is not necessarily the case for all inconsistencies (see above example about Peter). Additionally, depending on evaluative construal, ambivalence can be present in the absence of an inconsistency. Consider you are ambivalent about Bob, because he is cold (which you evaluative negatively), but he is also intelligent (which is positive). First, your overall evaluation of Bob is thus inconsistent, you evaluate him positively and negatively at the same time. However, the evaluative aspects which create your overall ambivalent (i.e. inconsistent) evaluation are only of opposing valence, but not logically inconsistent. That is, Bob being cold does not imply that he cannot be intelligent, or the other way around (for a similar argumentation, see Gawronski, 2012). Whether ambivalent information is inconsistent thus depends on the construal of the information in the context in which it is evaluated. If you evaluate Bob in order to decide whether he is a good analyst, his intelligence may be more important for your decision than his coldness. In this case, the evaluative aspects are consistent in the way that they suggest the same decision (‘yes, he may be a good analyst’) despite an overall inconsistent evaluation (Bob is positive and negative). However, if you evaluate Bob in order to decide

---

2 Yet, if Bob was unfriendly and friendly, this would not only create an overall inconsistent evaluation of Bob, but the evaluative aspects which create ambivalence would also be inconsistent.
whether he is a good bartender, for example, both evaluative aspects (intelligent and coldness) are important for your decision, but they suggest different choices. This creates inconsistency (and should lead to aversive feelings) according to the definition of Festinger: either choice (yes or no) will go against one aspect of your evaluation of Bob (intelligent or cold). You think Bob is intelligent, but you have decided that he is not a good bartender even though he is intelligent (a prerequisite for being a good bartender). To use Festinger’s term, you thus behave inconsistently with your ‘cognitions’. Notably, this is a special case of inconsistency, because even though you behave inconsistently (intelligent, yet not a good bartender), you also behave consistently with your cognition at the same time (cold, hence not a good bartender). Even though ambivalence is thus an inconsistency on an overall attitude level (simultaneous positive and negative evaluation which is logically incompatible) and therefore represents an evaluative conflict, processing ambivalent information in context can resolve this inconsistency as well as result in a special case of inconsistency, namely that of simultaneous consistency and inconsistency among ‘cognitions’. Cognitive dissonance may then be the aversive arousal that is experienced after processing inconsistent evaluations or behaving inconsistently with one’s ‘cognitions’. It can be compared with the discomfort that is often thought to be the consequence of ambivalence. However, the last word on when and how this discomfort is experienced as a consequence of ambivalence has not yet been spoken.

Ambiguity is another construct closely related to ambivalence. A stimulus is ambiguous when it cannot be identified or categorized due to a lack of sufficient cues (Budner, 1962). Imagine walking alone through a park at night and you see a figure in the dark that could be a tree or a person. The tree/person is an ambiguous stimulus, because you lack information to clearly categorize it - it may be a tree, or it may be a person. Contrary to ambiguity, ambivalence is not (necessarily) caused by a lack of information, but is characterized by strong positive and negative information (de Liver et al., 1997; Kaplan, 1972; Thompson et al., 1995). Ambivalence thus represents a conflict between opposingly valenced information, whereas ambiguity is not inherently characterized by conflicting valence but by insufficient information. Both ambiguity and ambivalence can result in uncertainty about which categorization of a stimulus is the correct one. Whereas there is always uncertainty in ambiguity, this is not the case for ambivalence: individuals are certain about their opposing evaluations – they find the stimulus positive and
negative at the same time instead of not knowing whether they find the stimulus positive or negative. As Clarkson, Tormala, and Rucker (2008) explained, someone can be very certain that chocolate tastes good (i.e. positive) and be certain that it has a lot of calories (i.e. negative). This person would thus be highly certain of his or her ambivalence toward chocolate, yet may be uncertain about which behavioral response (e.g., approach or avoid; for or against; yes or no) he or she should give based on the opposing evaluations.\(^3\) Uncertainty can thus be a consequence of ambivalence, and as such is reflected in the behavioral component (i.e. indecision) of the subjective ambivalence measure (cf. Priester & Petty, 1996).

Consequences of ambivalence

According to Festinger (1957), humans strive for consistency among thoughts, feelings, and behavior. Most consequences of ambivalence are ascribed to this human need for consistency, the primary consequence thought to be negative affect which is often suggested to be the driving force behind strategies to cope with ambivalence (e.g., van Harreveld, van der Pligt et al., 2009).

Affect as a response to ambivalence: the role of choice conflict

It is often suggested that ambivalence elicits negative affect based on the general idea that inconsistent thoughts about a stimulus produce negatively valenced arousal (i.e. cognitive dissonance; McGregor, Newby-Clark, & Zanna, 1999). Similarly, it can be argued that ambivalence elicits negative affect because conflicts are generally “aversive signals” (Dreisbach & Fischer, 2012): Processing conflicting information requires more cognitive effort (e.g., Botvinick, 2007), and conflicts disrupt processing fluency, resulting in negative affect (Phaf & Rotteveel, 2012; Topolinski & Strack, 2015; Winkielman & Cacioppo, 2001). Yet, evidence about affect as a response to ambivalence is somewhat inconclusive. In research on this matter, affect is often used in the broad sense of the word and includes “feelings, mood, emotion, and sympathetic nervous system activity that people experience in relation to an attitude object” (Eagly & Chaiken, 1998, p. 272).\(^4\) Taking this broad approach,

---

\(^3\) Interestingly, reflecting on ambivalent evaluations of a topic can even increase attitude certainty even though it activates opposing evaluations (Rucker & Petty, 2004; Rucker, Petty, & Briñol, 2008).

\(^4\) Because of this broad approach, researchers often refer to discomfort instead of negative affect when describing negative affective responses to ambivalence (van Harreveld, van der Pligt et al., 2009). In this dissertation, we will use the terms negative affect and discomfort interchangeably.
Hass and colleagues (1992) were among the first to report data that linked ambivalence to negative affect. They showed that exposing individuals who were ambivalent about racial issues to controversial (pro and con) racial statements about an incident in which a group of white teenagers had attacked three Black men, subsequently reported more negative mood than individuals who were not exposed to the statements. In order to explain the circumstances under which ambivalence leads to negative affect, Newby-Clark and colleagues (2002) suggested that negative affect occurs when conflicting evaluations are simultaneously accessible and conflict is thus salient. They repeatedly asked individuals to indicate their positive and negative evaluations about abortion on a potential ambivalence measure. Subsequently they assessed how torn and conflicted participants felt about abortion (cf. Jamieson, 1993). They reported that if both conflicting evaluations were made more accessible, participants experienced more conflict and felt more torn. Notably, Newby-Clark and colleagues used conflict experience as an indication of negative affect, but unfortunately did not specifically assess negative affect or emotions (Newby-Clark et al., 2002).

Yet there are also studies showing no association between ambivalence and negative affect, and there is even some evidence that ambivalence can result in less physiological arousal measured by skin conductance (GSR) than processing positive or negative information (Maio, Greenland, Bernard, & Esses, 2001). Maio and colleagues found that peak physiological arousal was lower in the seconds after participants had been told they would interact with a person, if they had been asked to think of positive and negative aspects of interacting with that person compared to when they thought of positive or negative aspects. However, measuring affect solely by physiological arousal may be misleading, as physiological arousal seems less related to (negative) affective valence than to affective extremity (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Larsen, Berntson, Poehlmann, Ito, & Cacioppo, 2008). It may thus be that positive and negative stimuli created more extreme affective responses, and thus more arousal, than ambivalent stimuli. Interestingly, Maio and colleagues found no effect of their ambivalence manipulation on specific, self-reported emotions (e.g., unhappy, glad), which led them to suggest that situational variables may determine whether ambivalence is experienced as negative. Having to make a choice about an ambivalent attitude object and anticipating negative consequences of this choice has been put forward as one such situational factor (van Harreveld,
Rutjens, Rotteveel, Nordgren, & van der Pligt, 2009). As Cohen and Basu remarked: “Since categorization produces a reduction in uncertainty, positive affect may result from a successful fit and negative affect from an inability to categorize an item – particularly if the resulting judgments [...] are important” (1987, p. 40). Van Harreveld and colleagues indeed observed that if participants were given ambivalent information on a societal topic, and subsequently forced to make a dichotomous (for/against) choice about the opinion they wanted to convey in a public article on the topic, they experienced more physiological arousal after having made the choice compared to when they could write a balanced article. Additionally, physiological arousal was mediated by self-reported uncertainty about decision outcomes, suggesting that in this study physiological arousal was related to negative feelings.

All in all, there seems to be preliminary evidence that ambivalence can, but does not have to result in negative affect. Identifying the circumstances under which ambivalence results in negative affect is consequential, because affect is thought to be the driving force behind individuals’ desire to resolve ambivalence and other coping mechanisms (Bleuler, 1911). In line with this idea, Nordgren, van Harreveld, and van der Pligt (2006) reported, for example, that ambivalent participants who felt more negative affect were more likely to engage in biased information processing such as generating more one-sided thoughts in order to reduce ambivalence. One of the aims of this dissertation is to further investigate the circumstances under which ambivalence elicits negative affect. We suggest that ambivalence only results in negative affect and changes in information processing when ambivalent evaluations are logically inconsistent in a choice situation (e.g., “Do you like Bob?” - “I like and dislike Bob”), thus creating choice conflict and impairing decision-making.

Coping with ambivalence

The conception that ambivalence can result in negative affect has led to an investigation of ways in which individuals cope with ambivalence. The Model of Ambivalence-Induced Discomfort (MAID) categorizes coping mechanisms into problem-focused and emotion-focused strategies, with problem-focused coping aimed at resolving ambivalence (and as a consequence reduce negative affect), and emotion-focused coping aimed at reducing negative affect without necessarily resolving ambivalence (van Harreveld, van der Pligt et al., 2009).
Problem-focused coping mostly refers to changes in information processing, such as more systematic processing or searching for new information that can help reduce ambivalence. Research has shown, for instance, that individuals process messages to a greater extent when it helped reduce ambivalence rather than when the message could potentially increase ambivalence (Clark, Wegener, & Fabrigar, 2008; see also Briñol, Petty, & Wheeler, 2006). Similarly, ambivalent individuals show a preference for unfamiliar information (indicated by self-reported desired exposure) that is expected to be effective in reducing ambivalence (Sawicki, Wegener, Clark, Fabrigar, Smith, & Durso, 2013). Resolving structural ambivalence (i.e. underlying associations) instead of temporarily resolving experienced ambivalence (i.e. current state of evaluative conflict) may be more difficult since changing the associative structure of one’s attitude is thought to be a slow process (e.g., Gawronski & Strack, 2004; Rydell & McConnell, 2006). In most situations, temporarily resolving evaluative conflict may be sufficient to reduce negative affect and alleviate the subjective experience of ambivalence. Based on the Iterative Reprocessing Model of Evaluation (IR Model; Cunningham, Zelazo, Packer, & van Bavel, 2007), I suggest in the current dissertation that when evaluative conflict (i.e. ambivalence) needs to be resolved (e.g., when having to make a choice), individuals use situational cues in order to change the evaluative weight of aspects of the stimulus which can help represent the stimulus in a less conflicted way. Consider, for example, you are standing in the supermarket having to decide whether or not to buy organic dinner ingredients. On the one hand, you may believe that buying organic products is positive because it is better for the environment; on the other hand, you may believe that buying organic products is negative because they are more expensive. The conflict between your evaluations of organic products (environmentally friendlier vs. more expensive) may trigger a search for cues in the situation that can help you make a choice (e.g., you have just gotten a pay check) by shifting the weight of your evaluations and temporarily reduce conflict (i.e. you can afford buying organic products today: the price of organic products becomes less important for your choice). In the present dissertation, the effect of situational information on negative affect (Chapter 3) and neurological networks activated by ambivalent decision-making will be investigated in an aim to identify networks involved in the detection and resolution of ambivalence (Chapter 4).
In general, resolving attitudinal ambivalence in order to create a one-sided evaluation requires cognitive effort (e.g., Cunningham et al., 2007; van Harreveld, Rutjens et al., 2009). Neuroimaging studies have, for example, shown that processing ambivalent information in order to make a valence-based choice (good vs. bad) is associated with greater activation in prefrontal regions including the ventrolateral prefrontal cortex (vLPFC) and anterior cingulate cortex (ACC) than processing univalent information or making non-valence judgments (Cunningham, Johnson, Gatenby, Gore, & Banaji, 2003; Cunningham, Raye, & Johnson, 2004). Also, evaluating ambivalent attitude objects seems to take more time than evaluating univalent (i.e. positive or negative) objects (Bargh, Chaiken, Govender, & Pratto, 1992; van Harreveld, van der Pligt, de Vries, Wenneker, & Verhue, 2004). This may especially be the case when evaluative context cannot help resolve conflict in the immediate decision moment. Because resolving ambivalence requires cognitive effort, the MAID (van Harreveld, van der Pligt et al., 2009) suggests that, if given the chance, ambivalent individuals try and delay a choice before engaging in processes aimed to effortfully resolve ambivalence. Delaying a choice is the most prominent emotion-focused coping mechanism described by the authors, yet evidence is still lacking indicating that being confronted with an ambivalent choice makes individuals more likely to delay a choice. Finally, this dissertation thus aims to answer the question whether ambivalent individuals indeed spontaneously delay a choice about a topic they are ambivalent about (Chapter 5). Additionally, we will take a step toward determining the effects of choice delay on negative affect and experienced ambivalence around the moment when a choice has to be made.

**Integrating diverse methods**

We use a diverse range of methods to study ambivalence and its consequences, including physiological (fMRI, facial EMG), self-report, and behavioral measures. Most of them do not require further introduction. Two physiological measures, however, are not regularly applied in social psychological research: facial EMG and fMRI. The advantage of physiological measures is that they assess an individual’s response continuously during an experimental session without interrupting the individual from the task at hand. Additionally, compared to self-report measures they are less susceptible to social desirability effects on the side of the participants.
Facial EMG

Affective states are often (willingly or unwillingly) communicated through facial expressions. A reliable and precise way to measure such affective responses is through facial EMG (van Boxtel, 2010). Even specific emotions may be inferred from facial muscle activity by looking at patterns of activation in different muscles. In this dissertation, recordings from two facial muscles will be used, the zygomaticus major and the corrugator supercilii, to infer general positive and negative affect in response to ambivalence. The zygomaticus major pulls the mouth up into a smile and reflects positive affect. The corrugator supercilii pulls the brows together into a frown and reflects negative affect. Recordings from both muscles are used to reliably distinguish between positive and negative affective states (Larsen, Norris, & Cacioppo, 2003). Next to the general advantage of physiological measures mentioned above, the specific advantage of facial EMG compared to self-report measures is that it allows to assess even those affective responses that are not visible to the human eye, indicating small but significant changes in affect.

Functional Magnetic Resonance Imaging

Additionally, fMRI will be used in two empirical chapters to further examine processes underlying ambivalent decision-making. fMRI is a non-invasive method that can monitor neural functioning relatively continuously during a task. It uses strong magnetic fields to assess changes in blood oxygenation in the brain during specific experimental tasks. This is based on the knowledge that active brain regions use more oxygen and such changes can be detected by fMRI. By assessing blood oxygenation changes across tasks, we aim to link mental processes to different neural networks. Exploring neural activity which underlies certain tasks and linking this activity to behavioral outcomes can inform us on similarities and differences between certain tasks that are not necessarily observable on behavioral data alone (Aue, Lavelle, & Cacioppo, 2009). It may, for example, be that a process – choosing between two different objects (i.e. approach-approach conflict) or choosing between taking or leaving one object (i.e. approach-avoidance conflict) - may result in the same behavioral outcome (e.g., longer response times), but engage different neural networks pointing toward different processes being involved in both tasks. In this dissertation, we will use fMRI to gain insight into the similarities and differences between processing of ambivalent and univalent information as
well as to investigate the neural processes underlying the situational resolution of evaluative conflict.

**The present dissertation**

The aim of the present dissertation is to enhance understanding of how individuals are affected by and subsequently deal with attitudinal ambivalence. I will especially focus on three aspects: the when and how of negative affect elicited by ambivalence, (neural) processes underlying the resolution of ambivalence in choice situations, and coping with ambivalence by delaying an ambivalent choice. First, the circumstances under which ambivalence elicits negative affect will be examined using physiological (fMRI, facial EMG) methods (Chapter 2 and 3). Second, the role of evaluative context (i.e. situational cues) in processing of ambivalence will be examined with a specific focus on the development and resolution of choice conflict (Chapter 3 and 4). Third, choice delay will be examined as a way of coping with ambivalence that does not necessarily involve resolving ambivalence, but is thought to reduce negative affect by distraction from ambivalence (Chapter 5).

**Overview of the chapters**

Chapter 2 will provide the basis for this dissertation and report a study in which functional Magnetic Resonance Imaging (fMRI) was used to map the engagement of brain regions activated when processing ambivalent information. The goal is to find support for the idea that processing ambivalent information in a choice situation does not only recruit higher order regions indicating more complex decision processes, but also engages brain regions associated with affective processes. This would indicate that making ambivalent choices is a complex informational and affective process, thereby complementing previous research on the involvement of affect in ambivalent decision-making (e.g., Hass et al., 1992; Newby-Clark et al., 1999; van Harreveld, Rutjens et al., 2009). Additionally, the effect of choice consequences (mild vs. severe) on neural networks engaged by ambivalent decision-making will be tested, to examine whether the anticipation of negative consequences of making a wrong choice is the driving factor for negative affect in ambivalent decision-making.

Whereas evidence on negative affect elicited by ambivalence has been mixed so far (e.g., Hass et al., 1992; Maio et al., 2001), in Chapter 3 the aim is to
further clarify the circumstances under which ambivalence elicits negative affect by introducing the concept of inconsistency and choice conflict as determining factor. Using a person perception paradigm, the idea is tested that having to make a choice is necessary for negative affect as a response to ambivalence. This idea is subsequently extended by testing the hypothesis that ambivalent information has to be inconsistent in the current choice situation in order to elicit negative affect. This will be done by presenting evaluative contexts which either put more emphasis on some evaluative aspect over another or keep both opposing evaluations equally relevant for the choice, under the hypothesis that ambivalence only results in negative affect if the opposing evaluations are inconsistent and create a choice conflict. Affect will be measured using facial electromyography (facial EMG), and experienced conflict by Priester and Petty’s (1996) subjective ambivalence scale.

Again taking a neuroimaging approach in Chapter 4, it will be investigated how presenting different evaluative contexts influences processing of ambivalent information in a choice context. After investigating whether affect and experienced ambivalence are indeed affected by evaluative context in which the ambivalent stimulus is encountered, we were especially interested in how the resolution of ambivalence is reflected by neural activation. This study served as a partial replication of findings reported in Chapter 2 and 3, as well as an extension to understanding brain regions involved in the situational resolution of ambivalence.

In Chapter 5 it will be examined how individuals deal with ambivalent choices if evaluative context cannot help resolve ambivalence. In the last empirical chapter, we thus turn to emotion-focused coping strategies and investigate choice delay as a coping strategy in the context of ambivalent decision-making. Four studies are reported, two studies conducted in the field, and two studies conducted in the lab. The first two studies test the hypothesis that ambivalent choices are more often delayed than choices on univalent topics. Subsequently, the third study investigates why individuals delay ambivalent choices, whether it is for distraction from or deliberation about the ambivalent topic. In the last study, we will examine whether distraction or deliberation is more successful during choice delay in reducing negative affect and experienced conflict around the choice moment if no new information is given.
Using diverse methods and different experimental approaches across studies, I hope to shed some further light on attitudinal ambivalence, its consequences, and the way individuals cope with ambivalence – be it through resolving ambivalence or delaying a commitment regarding the ambivalent topic. Of course, these chapters are not the final word on the affective and neural response to ambivalence, neither are they the final response on how individuals cope with ambivalence. Yet, I believe that the present studies will bring us a step further toward ‘solving ambivalence’. Thus in the final chapter our results will be integrated with earlier findings and I will discuss some issues and remaining questions that may provide directions for future research. Finally, please note that the chapters were written with the aim to make them comprehensible outside of the context of this dissertation. The reader may thus find some overlap between theoretical background discussed in each of the chapters.
Evaluating ambivalence:
Neural correlates of ambivalent decision-making

This chapter is based on:
Ambivalence, defined as the coexistence of opposing attitudinal positions, is a state that violates humans’ motivation to be consistent in thoughts, feelings, and behaviors (Festinger, 1964; Kaplan, 1972; Brinol & Petty, 2005; Proulx, Inzlicht, & Harmon-Jones, 2012). It is experienced in a broad range of situations, stretching from doing sports to broader societal issues, such as abortion or the use of nuclear energy. Ambivalent attitudes are cognitively complex (Cacioppo et al., 1997), can lead to the experience of conflicting emotions (e.g., Jonas, Diehl, & Broemer, 2000; Newby-Clark et al., 2002), and are thought to be experienced as aversive when making high stake decisions (van Harreveld, Rutjens, Rotteveel, Nordgren, & van der Pligt, 2009; for an overview, see van Harreveld, van der Pligt, & de Liver, 2009).

Prior neuroscientific studies focused primarily on the cognitive complexity of ambivalent attitudes (viz. Cunningham et al., 2003; Cunningham et al., 2004; Jung et al., 2008). Cunningham and colleagues (2003), for example, observed that evaluating ambivalent famous names (e.g., Bill Clinton) elicits increased activity in ventrolateral prefrontal cortex (vPFC), especially when these names were evaluated on their conflicting evaluative dimension (good vs. bad) relative to when they were classified into non-evaluative categories (e.g., past vs. present). These findings were thought to indicate more effortful information processing for ambivalent concepts (Cunningham et al., 2003).

Additional evidence for the cognitive complexity of processing ambivalent attitudes was provided in a follow-up study showing that evaluating ambivalent, socially relevant concepts (e.g., immigration) on the evaluative good-bad dimension was positively correlated with activity in areas that are activated during tasks requiring cognitive control, including the anterior cingulate cortex (ACC; Cunningham et al., 2004). This correlation was not found when the ambivalent concepts were assessed on a non-evaluative dimension (e.g., abstract vs. concrete), suggesting that the neural circuits involved in processing of ambivalent information may depend on whether conflict between evaluative aspects is relevant for the task at hand and thus salient.

Despite the progress that has been made in understanding brain regions involved in the processing of ambivalence on a higher-order cognitive level, no prior studies examined neural correlates of the affective consequences of ambivalence. This is surprising as research has suggested that ambivalent attitudes present an inconsistency among attitude components that can be
experienced as aversive. For example, it has been demonstrated that ambivalence elicits more negative affect when one has to make a consequential dichotomous choice about an ambivalent topic (van Harreveld, Rutjens et al., 2009). Van Harreveld and colleagues provided participants with either univalent or ambivalent information and subsequently asked them to write an article on this topic which was likely to be published in a newspaper. Participants receiving ambivalent information were either forced to form a univalent judgment on the topic, or they were allowed to express an uncommitted, mixed attitude. Ambivalent individuals who had to choose one side of the topic experienced more physiological arousal as measured by electrodermal activity and reported more negative affect after the choice was made. This was attributed to the anticipation of possible negative consequences of their choice. Prior studies demonstrated that the experience of negative emotional states in general and the generation of physiological arousal is associated with elevated activity in several brain regions, including the insula (Critchley, 2005; Critchley, Elliott, Mathias, & Dolan, 2000; Phan et al., 2004), a limbic forebrain area thought to serve as a hub for the integration of affective and cognitive processes (Craig, 2009) and contributes to the subjective experience of emotions (Mériau et al., 2009). Critchley and colleagues (2000) showed, for example, that spontaneous fluctuations of physiological arousal measured by electrodermal activity during a card game with faked feedback was correlated with activation changes in the anterior insula. Given that experiencing ambivalence is thought to result in negative affect and physiological arousal when ambivalence is relevant based on current task demands, these findings suggest that ambivalence is associated with enhanced activity in the insula when individuals anticipate negative consequences of their judgment.

Additionally, the cognitive complexity of ambivalence in a choice situation requires individuals to change decision strategies in order to come to a conclusion. Instead of being able to express a straightforward response that follows from a univalent evaluation, individuals have to retrieve, integrate and process additional information which may help to resolve ambivalence in the choice moment. One of the neural regions that has been suggested to activate when unexpected events happen that ask for a shift in attention and change in behavior, is the posterior cingulate cortex (PCC; Pearson et al., 2011). The PCC is a region with a high metabolic rate, which may indicate its vital role in the information exchange in the brain (Raichle et al., 2001),
especially when changes in the environment ask for an adjustment of behavior and mental strategies (Leech, Braga, & Sharp, 2011). The PCC/precuneus5 is often coactivated with the medial PFC, temporal lobes and temporal parietal junction (TPJ) as part of the social brain network. This is a network of regions found more activated during many social cognition tasks (Adolphs, 2009; Rilling & Sanfey, 2011). Interestingly, a part of this network is also more activated when evaluating ambiguous stimuli. Todorov and colleagues have reported greater activity in medial PFC and precuneus when individuals evaluate ambiguous faces that fall in the middle of the trustworthiness dimension (Todorov, Baron, & Oosterhof, 2008). Similar to ambivalent stimuli, these ambiguous faces are difficult to categorize and it requires additional processing in order to draw inferences that can guide behavior. Because processing ambiguous information requires an alteration of behavioral and mental strategy in order to integrate complex information about one’s own evaluation and its implications, we hypothesized ambivalent decision-making to be associated with increased activation in the social brain network, including the mPFC and PCC/precuneus.

In this study, we examined the cognitive and affective components of ambivalent decision-making, subjectively experienced ambivalence as well as behavior aimed at coping with the negative affect ambivalence can elicit. Participants made evaluative for-against choices about pretested ambivalent or univalent (positive or negative) word stimuli that are personally or socially important (e.g., globalization, happiness, terrorism). An intricate component of the design was the extent to which the choice was made relevant, as it has been suggested that the anticipation of negative consequences is the driving force behind negative affect as a response to ambivalence (see Chapter 1). To disentangle the effects of choice and consequences, we thus manipulated the probability of negative consequences of choices about the attitude topics using a between-subjects design. The negative consequences of choices were related to monetary loss for all participants. However, dependent on between-subject condition, participants were instructed that it was either very probable (severe choice consequences) or less probable (mild choice consequences) that making a wrong choice would have negative consequences (i.e. they would lose money). The amount of money participants lost when reaching the threshold

5 The precuneus adjoins the PCC, and activation can cross the border between these two regions (also in this study) so that we are referring to them together.
of allowed wrong choices was equally high for all participants. After scanning, experienced ambivalence toward the attitude topics was measured by Priester and Petty’s (1996) subjective ambivalence scale. Additionally, individuals could compensate for uncertainty about their choices by buying so-called jokers that neutralized one possibly wrong choice each. This served as a behavioral measure of uncertainty and allowed us to test whether participants were indeed more uncertain about their choices on ambivalent than univalent topics.

We expected to replicate previous findings showing greater activity in ventrolateral PFC and ACC during ambivalent decision-making (Cunningham et al., 2004). Additionally, we anticipated greater engagement of a social-affective network during choices about ambivalent compared to univalent topics. This network includes the insula, reflecting the emotional intensity of the choice situation (Singer et al., 2009), as well as the PCC, pointing towards the role social-cognitive processes take in the induction and reduction of the negative experience of ambivalence. Finally, we expected greater activation in these networks during ambivalent decision-making when negative consequences of making a wrong choice were more likely as the anticipation of negative consequences has been suggested to be the driving force behind ambivalence-induced negative affect (van Harreveld, van der Pligt et al., 2009).

Methods

Participants

Forty-three students of Leiden University in the Netherlands, (24 female, 21 male) in the age range 18 to 25 years (\(M = 21, SD = 1.89\)) participated in the study in exchange for course credit or an equivalent monetary compensation. Two additional participants were excluded from the analyses because of technical problems with the obtained images or because they indicated not having followed experimental instructions. Participants were randomly assigned to either the severe choice consequences (N=21) or the mild choice consequences condition (N=22).

Prior to the study, all participants completed a checklist to make sure they were eligible to take part in an MRI study. All procedures were approved by the medical ethical committee of the Leiden University Medical Center and participants gave informed consent for the study. Anatomical scans were
examined by a radiologist in line with the University’s policies; no anomalies were found.

**Design and Procedure**

In the scanner, participants were presented with a total of 60 concepts, of which 30 had been rated as ambivalent (e.g., organ donation), 15 as positive (e.g., summer) and 15 as negative (e.g., child labor) in an earlier pilot study with other participants (N = 53). Participants’ task was to judge each concept upon whether they were ‘for’ or ‘against’ by pressing one of two buttons with their right hand. The choice category (for/against) corresponding to the button press was counterbalanced, so that half of the participants saw the option ‘for’ on the left side of the screen, while the other half saw it on the right side of the screen.

Items were displayed in 4 sets of 15 concepts each. Each set consisted of concepts of the same valence, so that two sets contained univalent concepts and two contained only ambivalent concepts. A blocked stimulus presentation (which was analyzed with an event-related design, see below) was used to simplify participants’ reference in the behavioral postmeasure (see below for more information). Importantly, participants were not instructed about the valence of the concepts displayed in the sets, so that they did not have expectations about the valence of the to-be-presented concepts. To control for the number of left and right button presses per set, positive and negative concepts were combined in sets of univalent trials. The order within all sets was randomized and the order across sets was counterbalanced in a way that two consecutive sets were of different valence (ambivalence vs. univalence).

Stimulus presentation lasted until participants made a response. A fixation cross preceded each trial which created a jittered interstimulus interval (min. = 4000ms, max. = 6600ms). After participants made a choice, a black screen was presented for 2500ms before the next trial started (see Figure 2.1b).

**Choice consequences.**

To test the effect of anticipating negative consequences, choice consequences were manipulated between-participants. We told all participants that we could determine their ‘true’ attitudes about each of the presented topics by measuring their physiological response (electrodermal activity) corresponding to their explicit choice. Dependent on choice consequence condition, we
varied the number of times they were allowed to make an ‘incorrect’ choice in the following way. All participants were told that they could earn up to €12 on top of the participant compensation dependent on their performance on the choice task during scanning. It was explained that the task includes judging a number of topics by categorizing them according to their opinion (for/against). Prior to scanning, an electrode was placed on the palm of participants’ left hand, which supposedly measured electrodermal activity (EDA). Unbeknown to participants, in reality EDA was not measured during the study and the cover story merely served as a way to have people think that we could judge their responses. Participants were told that measuring electrodermal activity was a common way of testing whether someone reports the truth (i.e. a bogus lie-detector). In reality, there were neither right nor wrong choices nor were we able to tell whether participants’ choice reflected their ‘true’ attitude.

Figure 2.1
Display of a) design of the study, and b) timing sequence of a trial of the scanner task.

After having been placed inside the scanner, participants in both conditions were instructed to respond as honestly as possible during the evaluation task. In the severe choice consequences condition, participants were instructed that
their data would only be useful if their choice matched their ‘true attitude’ on more than 90% of the evaluations. This instruction aimed at making each choice trial more important. In the mild choice consequences condition, the percentage of ‘necessary correct answers’ was 60%, thus decreasing the pressure to be correct on each choice. Participants in both conditions were told that they would lose €3 of their seed capital (i.e., €12) per set of choices that exceeded the percentage of ‘allowed wrong answers’.

To familiarize themselves with the task, participants went through four test trials by categorizing two ambivalent and two univalent concepts before the experimental trials (see Figure 2.1a for a schematic overview of the design).

**Subjective ambivalence and coping behavior.**

To test post-decisional ambivalence and uncertainty about the chosen option, two post tests were administered immediately after the scanning session. First, participants rated each previously evaluated stimulus on Priester and Petty’s subjective ambivalence scale (1996). This measure consists of three items based on the tripartite model of attitudes (e.g., Ostrom, 1969) and assesses the affective, cognitive, and behavioral components of the ambivalent attitude. The three items were anchored with “Toward this topic I...” have completely one-sided feelings, feel no conflict, and feel no indecision (0) and have mixed feelings, feel maximum conflict, and maximum indecision (100). Responses were given using a slider ($\alpha = .94$).

In order to prevent participants from forming an opinion about the topics before entering the scanner, subjective ambivalence was only assessed outside the scanner after the experiment. We relied on the aforementioned pretest of a different group of participants for the selection of appropriate stimuli.

Secondly, we used a behavioral measure to assess participants’ uncertainty about the choice they had made. As part of the experiment, participants were instructed that they were only allowed to give a prespecified number of wrong answers (10% or 40%), otherwise it would cost them up to €3 per set of choices exceeding this percentage. Participants were given the possibility to buy ‘jokers’ to compensate for choices they were uncertain about. Jokers cost €0.50 which was taken out of their seed capital and compensated one ‘wrong’ choice per specified set of 15 choices. For example, buying two jokers would allow for three instead of one ‘error’ in the severe choice consequences condition. Participants did not specify the particular choice they were
uncertain about, but indicated for which set of choices they wanted to buy jokers (set 1 - 4).

**MRI Data Acquisition**

Scanning was performed with a standard whole-head coil on a 3.0 Tesla Philips Achieva scanner at the Leiden University Medical Center (LUMC). To limit head motion to a minimum, foam inserts were placed around the head inside the head coil. Using E-Prime, stimuli were projected onto a screen in the magnet bore which participants could see through a mirror attached to the head coil. The choice task consisted of one event-related run, lasting approximately 8 minutes. Functional data were obtained using T2*-weighted echo-planar imaging (EPI). The first 2 volumes were removed to allow for equilibration of T1 saturation effects (TR = 2.2 sec, TE = 30 msec, sequential acquisition, 38 slices of 2.75 mm, field of view 220 mm, 80 x 80 matrix, in-plane resolution 2.75 mm). A high-resolution 3D T1-FFE scan for anatomical reference was collected (TR = 9.760 ms; TE = 4.59 ms, flip angle = 8 degrees, 140 slices, 0.875 x 0.875 x 1.2 mm³ voxels, FOV = 224 x 168 x 177 mm³). After the functional runs, a high resolution 3D T1-weighted anatomical image was obtained (TR= 9.751 ms, TE=4.59 ms, flip angle= 8°, 140 slices, 0.875mm x 0.875mm x 1.2mm, and FOV= 224.000x168.000x177.333).

**fMRI Data analysis**

Data preprocessing and analyses were carried out using SPM5 (Wellcome Department of Cognitive Neurology, London). Rigid body motion correction was applied. Movement parameters were below 3 mm for all participants and scans. Functional volumes were spatially normalized to EPI templates. The spatial normalization algorithm applied a 12-parameter affine transformation with a nonlinear transformation involving cosine basis functions, and subsequently resampled the volumes to 3-mm cubic voxels. Templates were based on the MNI305 stereotaxic space (Cocosco, Kollokian, Kwan, & Evans, 1997), and the MNI atlas was used to refer to the coordinates. An 8-mm full-width-at-half-maximum isotropic Gaussian kernel was used to spatially smooth the functional volumes. Statistical analyses were carried out on individual participants’ data using the general linear model in SPM5.

The data were modeled by a series of events convolved with a hemodynamic response function (HRF). Trials were modeled based on the onset of stimulus presentation, specified as zero-duration events. In a second post hoc analysis
the data were analyzed with reaction time (RT) as a duration regressor. These results largely overlapped with the model using zero-duration vectors (see Table 2.1), therefore, the RT model is not further described. The trial functions were used as covariates in a general linear model, along with a basic set of cosine functions to high-pass filter the data. The least-squares parameter estimates of the height of the best-fitting canonical HRF for the different conditions were used in pairwise contrasts.

Three main contrast analyses were distinguished. Activity during evaluations of ambivalent topics was contrasted with evaluations of univalent topics (ambivalent > univalent; univalent > ambivalent). Second, we contrasted ambivalent evaluations with positive evaluations (ambivalent > positive) and with negative evaluations (ambivalent > negative) to examine the role valence plays in ambivalent decision-making. Third, group differences were tested using two-sample t-tests. Only effects of at least 10 contiguous voxels that exceeded a FDR corrected threshold of \( p < .05 \) are reported. In addition to analyses on the whole-brain level, we further tested for effects of the between-subject factor choice consequences in subsequent ROI analyses. ROIs were extracted using the Marsbar toolbox for SPM5 (Brett et al., 2002).

Results

Behavioral Measures

Behavioral results during scanning.

A repeated measures ANOVA was performed on reaction times (RTs) with stimulus valence (univalence vs. ambivalence) as a within-subject factor and choice consequences (mild vs. severe) as between-subject factor. As predicted, RTs were slower for ambivalent evaluations (\( M = 1.88\text{s}, SD = .55\text{s} \)) than for evaluations of univalent topics (\( M = 1.30\text{s}, SD = .38\text{s} \)), \( F(1,41) = 122.86, p < .001, \eta^2 = .75 \). No effect was found of the severity of choice consequences, \( F(1,41) = 1.04, p = \text{ns} \).

Secondly, we assessed the distribution of participants’ valence categorization of target stimuli. Conform our expectations, positive stimuli were mostly evaluated positively (‘for-category’; 98.8%) and negative stimuli were mostly evaluated as negative (‘against-category’; 97.4%). Categorization of ambivalent stimuli was mixed, with stimuli being evaluated positively in 69.7% of the cases and negatively in 30.3%. 
Behavioral results outside of the scanner.

Data of four participants (3 female) were lost due to technical problems. This was only the case for the behavioral measure of uncertainty, participants’ ratings of subjective ambivalence were unaffected.

Subjective ambivalence.

A subjective ambivalence score about each topic was calculated by taking the mean of participants’ self-reported conflicting thoughts, indecisiveness, and mixed feelings about each topic. As expected, participants experienced more subjectively experienced ambivalence about the ambivalent topics ($M = 31.08$, $SD = 11.00$) than univalent topics ($M = 14.80$, $SD = 13.14$), $F(1,41) = 67.63$, $p < .001$, $\eta^2 = 62$. There was no main effect of choice consequences, and no interaction between choice consequences and ambivalence (all $p$’s = ns).

Coping behavior.

As expected, participants displayed more uncertainty-compensating behavior for choices regarding ambivalent than univalent topics. When given the possibility to buy jokers in order to compensate for possibly wrong choices made during the choice task, more jokers were purchased for ambivalent trials ($M = 1.87$, $SD = 1.51$) than for univalent trials ($M = .44$, $SD = .72$), $F(1,37) = 37.82$, $p < .001$, $\eta^2 = .51$. Again, no effect was found of choice consequences, $F(1,37) = 1.138$, $p = .29$.

The number of jokers purchased to compensate for possibly wrong choices about ambivalent topics correlated significantly with subjective ambivalence participants felt about the ambivalent topics, $r = .33$, $p = .04$, demonstrating that the experience of ambivalence is associated with uncertainty about previous decisions regarding the ambivalent topics. No such correlation was found for univalent topics, $r = .17$, $p = ns$.

Neuroimaging Results

Whole-brain contrasts.

BOLD signal during ambivalent trials was contrasted with the signal during univalent trials (ambivalent > univalent). Results revealed that a network of regions was more activated during choices about ambivalent topics, including the dorsal ACC extending into the lateral PFC, ventral ACC, insula, TPJ, and the precuneus/PCC (see Figure 2.2). No significant activity was found in the
reverse contrast (univalent > ambivalent) indicating that univalent choices did not lead to greater activation than ambivalent choices. All significant clusters are reported in Table 2.1.

Table 2.1. Brain regions revealed by whole brain contrast: Ambivalent > univalent. No significant clusters were found for the evaluation of univalent > ambivalent stimuli.

<table>
<thead>
<tr>
<th>Anatomical Region</th>
<th>Left/Right</th>
<th>Voxels</th>
<th>MNI coordinates</th>
<th>RT Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>TPJ</td>
<td>L</td>
<td>197</td>
<td>-45</td>
<td>-66</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-54</td>
<td>-69</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-39</td>
<td>-54</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>84</td>
<td>57</td>
<td>-66</td>
</tr>
<tr>
<td>insula</td>
<td>L</td>
<td>22</td>
<td>-39</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-45</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-33</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>27</td>
<td>39</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>39</td>
<td>15</td>
</tr>
<tr>
<td>ACC</td>
<td>ventral</td>
<td>1810</td>
<td>6</td>
<td>51</td>
</tr>
<tr>
<td>SFG</td>
<td></td>
<td>-18</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>dorsal/(pre-)SMA</td>
<td></td>
<td>3</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td>Precuneus/PCC</td>
<td>L</td>
<td>844</td>
<td>-3</td>
<td>-54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-6</td>
<td>-45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>-48</td>
</tr>
<tr>
<td>Central gyrus</td>
<td>L</td>
<td>155</td>
<td>-33</td>
<td>-15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-42</td>
<td>-9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-39</td>
<td>-27</td>
</tr>
<tr>
<td>Temporal Lobe</td>
<td>L</td>
<td>210</td>
<td>-33</td>
<td>-90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-18</td>
<td>-96</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-42</td>
<td>-72</td>
</tr>
<tr>
<td>Temporal gyrus</td>
<td>L</td>
<td>18</td>
<td>-57</td>
<td>-12</td>
</tr>
<tr>
<td>Occipital lobe</td>
<td>R</td>
<td>76</td>
<td>39</td>
<td>-93</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td>-99</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>-90</td>
</tr>
<tr>
<td>paraHippocampal</td>
<td>R</td>
<td>13</td>
<td>21</td>
<td>-27</td>
</tr>
</tbody>
</table>

All clusters reached an FDR corrected significance level of $p = .05$ and exceeded the minimum threshold of 10 voxels. The coordinates of the maximally activated voxel is given for each cluster.

* Results remained significant when including RTs as a duration factor.
The contrast ambivalent > positive revealed a pattern of activation that highly overlaps with the network found for the contrast ambivalent > univalent. The ambivalent > negative contrast resulted in a network of activity which partly overlapped with the network detected in the ambivalent > univalent contrast. More activity was found for ambivalent evaluations in the dACC, vACC, TPJ (bilateral), and the precuneus/PCC, but insula activity did not differ significantly between evaluations of ambivalent and negative issues.

A direct comparison of ambivalent > univalent for the mild and the severe consequences condition (i.e. a two-sample t-test) did not result in any significant activation in either direction. However, it is possible that small differences in activation fail to reveal statistical threshold in whole-brain analyses. Since we had a priori predictions about the activity pattern dependent on evaluation consequences, Region-of-Interest (ROI) analyses were conducted.

Figure 2.2
Whole brain contrast: ambivalent decision-making > univalent decision-making.

Region-of-interest analyses.

Regions of interest (ROIs) were determined based on the brain areas that distinguished between ambivalence and univalence in decision-making processes (ambivalent > univalent, across all participants). ROI analyses were conducted to test for interaction between ambivalence and choice consequence conditions. The following regions were selected by drawing a 6 mm sphere around the most active voxel: bilateral insula (MNI 39, 15, -12 and -39, 12, 9), bilateral TPJ (MNI 57, -66, 30 and -45, -66, 33), dorsal ACC (MNI 3, 21, 45), ventral ACC (MNI 6, 51, -6) and the precuneus/PCC (MNI -3, -54, 15) (see Figure 2.3).
None of these regions showed significant main or interaction effects with choice consequences condition except for the ventral ACC. In this region, a main effect of consequences condition indicated that more severe choice consequences were associated with greater activation compared to choices that were less consequential, $F(1,41) = 4.516, p = .04, \eta^2 = .10$. No interaction with ambivalence was found.

**Discussion**

The present study investigated the neural correlates of ambivalent decision-making by asking participants to make dichotomous evaluative choices on ambivalent and univalent target stimuli. We put an emphasis on choice consequences in line with the idea that the anticipation of negative consequences of one’s chosen option is the driving force of negative affect in ambivalent decision-making. The study resulted in three main findings. Consistent with prior studies, ambivalent decision-making resulted in dorsal and ventral ACC activation, extending into the lateral PFC (Cunningham et al., 2004). Second, ambivalent decision-making engaged a social-affective network including the insula, precuneus/PCC, and TPJ. Third, the severity of choice consequences neither affected the way ambivalence was processed during the choice task, nor how much ambivalence participants experienced after the choice task. The discussion is structured along these main findings.

Ambivalence represents simultaneous positive and negative associations with a stimulus. When evaluating ambivalent stimuli on the valence dimension, this inconsistency asks for cognitive control in order to inhibit one reaction and follow through with another (Cunningham et al., 2004). Processing of ambivalent stimuli has previously been associated with activation in the ACC,
vIPFC, and there has also been some evidence for greater activation in the
orbital frontal cortex (Cunningham et al., 2003; Jung et al., 2008). Our study
partly replicates these findings showing greater ACC and lateral PFC activity
during ambivalent decision-making compared to univalent decision-making
(see also Nomura et al., 2003; Simmons et al., 2006), and thereby confirms the
prominent role of the prefrontal cortex in complex decision-making situations
(see Bunge et al., 2002).

Previous neurological studies have predominantly focused on the cognitive
complexity of processing ambivalence. However, recent studies demonstrated
that being confronted with one’s ambivalence in decision-making situations
can result in negative affect when anticipating negative consequences of one’s
decision (van Harreveld, Rutjens, et al., 2009). As expected, the current study
demonstrated that ambivalent stimuli led to greater activation in a social-
affective network including the insula, PCC/precuneus, and TPJ in the
context of an emphasis on potentially wrong choices that could have negative
consequences.

It was hypothesized that activity in the insula reflects the negative emotional
state individuals experience when confronted with ambivalence in a choice
situation (e.g., Critchley, 2005; Critchley, Elliott, Mathias, & Dolan, 2000; Phan
et al., 2004). We observed more activity in the insula for ambivalent compared
to positive stimuli, and no significant difference in insula activity for negative
compared to ambivalent trials. This could mean one of two things. Either
ambivalence elicits similar levels of negative affect as evaluating negative
stimuli in that processing ambivalent information is not more negative than
processing negative information, or it could suggest that insula activation
reflects the negative valence component of ambivalent stimuli instead of the
aversive state ambivalence can elicit. Both explanations are supported by
other findings in that greater activity in the insula has, for instance, been
reported during the processing of negative words (Straube et al., 2011), which
can either be explained as insula activation reflecting the processing of
negative valence of the stimulus or the negative affective response to
processing a negatively valenced stimulus. Nevertheless, we believe that the
affective response to processing ambivalence can be meaningfully
distinguished from processing negatively valenced information. Using the
ROIs reported above we found a tendency for insula activity to be related to
more uncertainty-compensating behavior (i.e. buying more jokers) for
ambivalent than negative trials (however, this correlation did not survive Bonferroni corrections). The arousal response that is reflected in insula activity may thus have a differential effect on behavior depending on whether it is elicited by negative or ambivalent stimuli, suggesting that the response is less based on the negative valence component than the affective response to the overall, ambivalent stimulus.

We predicted that ambivalent decision-making would also be associated with activation in the social brain network, and especially greater activation in PCC/precuneus and mPFC. Additionally, we found greater activation in the TPJ. The PCC and TPJ are functionally connected, and both engaged in situations that require the integration of information through mentalizing, self-reflection, and self-projection, i.e. the act of thinking about different future outcomes and referencing these alternative outcomes to oneself (Buckner & Carroll, 2006; Mars et al., 2012; Saxe, 2010). This may be especially vital in ambivalent decision-making when individuals think about possible outcomes of each of the desirable and undesirable choice outcomes, which is often thought to be the source of anticipated regret when making ambivalent choices (van Harreveld, van der Pligt et al., 2009). The PCC is a central hub in the social brain network and has been suggested to signal the need to alter behavioral strategies due to changes in the environment (Leech & Sharp, 2013; Pearson et al., 2011). It has, for example, been linked to the processing of moral conflicts (Sommer et al., 2010) and the evaluation of ambiguous faces (Todorov et al., 2008), both situations in which expectancy violations ask for an integration and resolution of a complex stimulus. Buckner and Carroll (2007) suggested that TPJ and PCC/precuneus together with prefrontal regions such as the mPFC are engaged by social and cognitive problem solving, for example complex decision-making processes that call for an analysis of oneself in another perspective, time, or place (see also Mars et al., 2012). Additionally, the TPJ plays a central role in Theory of Mind-processes, i.e. the ability for metacognition (ToM; Fletcher et al., 1995; Gallagher et al., 2000; van Overwalle, 2009). Possibly, these regions are engaged due to social and situational perspective-taking, in that individuals try to resolve ambivalence by reflecting on their own and others’ opinion under differing circumstances and thinking about possible outcomes of choosing one option over the other.
Contrary to expectations, the probability of choice consequences did not interact with ambivalence. Ambivalent stimuli were not differentially processed dependent on the probability of negative choice consequences. Additionally, independent of the probability of negative choice consequences, we found greater insula activity for ambivalent than univalent stimuli (and similar activity levels when processing negative stimuli, see above). Possibly, anticipating negative consequences of a wrong choice does not necessarily make ambivalence aversive. Similar to the idea of cognitive dissonance, it may be that forcing individuals to make a choice about an ambivalent topic, and thus choose inconsistently with their attitude, is sufficient to elicit negative affect. This idea will be further investigated and discussed in later chapters.

Not finding an interaction of ambivalence and the probability of choice consequences also eliminates a potential alternative explanation of the observed effects. Even though being forced to make an evaluatively unequivocal choice about an ambivalent topic mirrors many real life situations (e.g., abortion), the setup of this study might have led participants to feel judged unfairly when having to report their real (mixed) attitude, but not being able to do so. However, a higher probability of choice consequences only led to greater activity in the ventral ACC independent of stimulus valence, thus disconfirming this alternative explanation. Compared to the dorsal ACC, the ventral part of the ACC is more affect-oriented since it is functionally connected to other emotion-related areas like the amygdala and anterior insula (Bush et al., 2000; Kanske & Kotz, 2011). This is in line with our findings, in that a higher probability of negative choice consequences led to greater emotional relevance of all stimuli independent of stimulus valence as reflected in greater ventral ACC activity.

Taken together, the current results bring us a step closer to understanding how ambivalent information is processed in the brain and how different neural processes are involved in the experience of ambivalence. It was shown that processing ambivalent information is not only cognitively more complex than processing univalent information, but ambivalent decision-making also engages a social-affective network, including the insula, PCC and TPJ. Additionally, manipulating the probability of negative consequences of choices about ambivalent topics did not influence how ambivalence was processed or the self-reported experience of evaluative conflict, indicating that
the anticipation of negative consequences may not be the driving factor of negative affect as a response to ambivalence.
Chapter 3

On the affective nature of ambivalence:
A facial EMG study on the role of choice and evaluative context in shaping affective responses to ambivalence.

This chapter is based on:


We thank Bert Molenkamp for technical assistance regarding the EMG measurement and Ard Barends for his assistance during data collection.
Attitudinal ambivalence is the simultaneous existence of positive and negative associations with regard to a person, object or issue (Kaplan, 1972). Ambivalence has become a central concept in attitude research over the past decades, in which researchers revised initial claims that positivity and negativity cannot co-exist within one attitude (Cacioppo, Gardner, & Berntson, 1997; Thurstone, 1928). Based on Festinger’s idea that inconsistent thoughts about a reference object produce negatively valenced arousal (Festinger, 1957; Gawronski, 2012), it has likewise been suggested that ambivalence directly elicits negative affect (McGregor et al., 1999). Parallels can also be drawn between potentially negative responses to ambivalence and negative responses to a disruption of processing fluency (Phaf & Rotteveel, 2012; Topolinski & Strack, 2015; Winkielman & Cacioppo, 2001), and the idea that processing conflicting information requires more cognitive effort and may therefore be aversive (e.g., Botvinick, 2007). In a number of studies it was shown, for example, that conflict Stroop primes (color word blue printed in yellow) led to faster evaluation of negative targets than non-conflict Stroop primes (color word blue printed in blue; Dreisbach and Fischer, 2012; but see Schacht, Dimigen, and Sommer, 2010) as well as a greater proportion of negative evaluations of neutral targets (Fritz & Dreisbach, 2013). These results led Dreisbach and Fischer (2012) to conclude that conflicts may be ‘aversive signals’. Based on the idea that ambivalent stimuli possess conflicting evaluative components, ambivalence may also be considered an aversive signal and, consequently, processing ambivalent information should elicit negative affect. However, evidence for a relation between ambivalence and negative affect has been mixed, with some studies reporting a positive relation (Hass, Katz, Rizzo, Bailey, & Moore, 1992), some a negative relation (Maio, Greenland, Bernard, & Esses, 2001), and others showing that a negative affective response to ambivalence is contingent on having to make a dichotomous, consequential choice (van Harreveld, Rutjens, Rotteveel, Nordgren, & van der Pligt, 2009). After having found that manipulating the probability of negative choice consequences does not influence processing in emotion and arousal-related brain regions (Chapter 2), in the current study we aim to contribute to reconciling previously inconclusive results on the affective response to ambivalence by suggesting that ambivalence is only responded to negatively if it creates a choice conflict based on inconsistent evaluations. When a choice has to be made with respect to an ambivalent...
stimulus, evaluative context can be taken into account with the goal to resolve inconsistency and thus alleviate negative affect.

Initial evidence that ambivalence leads to negative affect comes from Hass and colleagues (1992). They reported that exposing racially ambivalent participants to controversial (pro and con) racial statements was related to a greater increase in self-reported negative mood than exposing less ambivalent participants to the same statements. Contrary to this finding, Maio and colleagues (2001) observed no relationship between ambivalence and self-reported negative affect in an intergroup context (Study 2), and even found a negative correlation between ambivalence and physiological arousal measured by skin conductance (GSR) when participants were asked to report their attitude towards groups of different nationalities (Study 1). Newby-Clark, McGregor, and Zanna (2002) suggested that simultaneous accessibility and awareness of contradictory evaluations leads ambivalent individuals to experience conflict (i.e. ‘discomfort’, often equated with negative affect in the ambivalence literature; see van Harreveld, Nohlen, & Schneider, 2015; van Harreveld, van der Pligt, & de Liver, 2009; Chapter 1). However, van Harreveld, Rutjens and colleagues (2009) reported that being ambivalent only resulted in more physiological arousal and negative affect when ambivalent individuals had to commit (i.e. forced choice) to one side of their evaluation, compared to noncommittal ambivalent individuals and individuals who were univalent (i.e. positive or negative) about an attitude topic. Notably, they reported an increase in negative affect only after the choice had been made, suggesting that ambivalence may be negative when individuals have behaved inconsistently with their attitude.

These seemingly contradictory results may partly be explained by different operationalizations of ambivalence as well as differences in when and how affect is measured across these studies (i.e. physiological arousal, implicit mood measure, subjective ambivalence scale). Based on the idea that ambivalence represents an evaluative conflict, and conflicts are suggested to be aversive signals (Dreisbach & Fischer, 2012), it can be argued that processing of ambivalent information should elicit negative affect even in the absence of additional factors such as having to make a choice (i.e. van Harreveld, Rutjens, et al., 2009), or having to interact with someone you evaluate ambivalently (i.e. Maio et al., 2001). Other accounts suggest, however, that response selection is necessary for the detection of conflict.
Ambivalence and affect | 49

(Botvinick, Braver, Barch, Carter, & Cohen, 2001). Similarly, Winkielman, Olszanowski, and Gola (2015) have shown that disfluency effects (i.e. longer RTs) to targets with mixed characteristics (e.g., female and male facial features) only occur if targets have to be evaluated on the conflicting dimension (i.e. gender), thus when disfluent information is task-relevant and has to be responded to. In order to get a clearer picture of the role of choice in eliciting a negative affective response to ambivalence and to test whether ambivalence represents a conflict that is by itself aversive, we first assessed spontaneous affective responses to ambivalence in the absence (stimulus exposure) and presence of a (non-consequential) forced choice context.

Another important aspect influencing whether ambivalence is experienced as negative can be derived from Festinger’s cognitive dissonance theory (1957). According to Festinger’s original formulation of the theory, consistency is a fundamental human motive such as thirst or hunger. Two thoughts, beliefs, or feelings (x and y) are inconsistent “if not-x follows from y” (p. 13). An ambivalent attitude represents such an inconsistency, in that a stimulus is simultaneously evaluated positively and negatively (e.g., “I like and dislike Bob”). Along this line of reasoning, for many years ambivalence was thought to elicit negative affect (e.g., Briñol & Petty, 2005; McGregor, Newby-Clark, & Zanna, 1999). However, ambivalent evaluations are based on our associations with a stimulus that have a certain positive or negative value. For example, I may like Bob, because he is intelligent (= positive), but at the same time I may dislike Bob, because he is dominant (= negative). Whereas my general attitude towards Bob then represents an inconsistency (“I like and dislike Bob”), the two associations that make up the ambivalent attitude are not inconsistent: Bob being intelligent does not logically exclude Bob from being dominant. Rephrasing ambivalence in terms of an inconsistency sheds more light on when ambivalence should result in negative affect and when it should not.

Choice may then serve as an evaluative context that determines whether the inconsistency of the general ambivalent attitude is relevant or not. For example, if you are asked whether Bob is intelligent, the inconsistency of ambivalence (like and dislike) is present but irrelevant, because whether you think Bob is dominant has nothing to do with whether you find him
intelligent or not. In this case, evaluative context can be used to change the weight of associations with the stimulus that can help represent the stimulus in a less conflicted way. However, if you have to decide whether Bob is a good collaborator, thus both evaluative aspects are relevant and predict different choice behavior, evaluations are inconsistent in the current situation and ambivalence is experienced as negative. In other words, ambivalence may only be experienced as negative if it creates choice conflict. If ambivalence is present, but the opposing valence of associations is irrelevant in the current context, ambivalence does not elicit negative affect.

The current study was designed to test the preconditions for negative affect elicited by ambivalence, and explore whether evaluative context can regulate a negative affective response to ambivalence by influencing whether ambivalent evaluations are inconsistent. First, we aimed to investigate whether ambivalence directly elicits negative affect as suggested by McGregor and colleagues (1999), by measuring facial EMG activity while exposing participants to ambivalent stimuli that are not relevant for the task at hand (task 1). Even though a physiological study using GSR (van Harreveld, Rutjens et al., 2009) suggests that ambivalence does not elicit physiological arousal in the absence of a forced choice context, we aimed to test this hypothesis using a physiological measure that can assess positive and negative valence (facial EMG) instead of only arousal (cf. Hamm, Schupp, & Weike, 2003). Second, we tested whether ambivalent stimuli elicit more negative affect and less positive affect when a choice has to be made on the (conflicting) valence dimension (task 2). Third, we were interested if and how evaluative context in the choice moment itself influences the affective response to ambivalence (task 2). That is, if evaluative context helps resolve evaluative conflict, is this reflected in both, implicit measures of affect (i.e. facial EMG) as well as self-reported conflict and how quickly are effects of evaluative context observed on continuous measures?

The current study

Using facial electromyography (fEMG) in a person perception paradigm we assessed affective responses to ambivalent and univalent information by presenting target names in association with positive and/or negative trait characteristics (e.g., X is friendly and dumb). Trait characteristics were presented under circumstances in which conflicting components were both accessible but did not have to be responded to (stimulus exposure; task 1), and
under circumstances in which participants had to respond to the stimulus in a forced-choice paradigm (forced choice; task 2). In this second task, we created evaluative contexts that either put more weight on one of the conflicting evaluative aspects (or not) by varying the context in which the forced choice had to be made. This was done to create evaluative contexts in which inconsistency could be situationally resolved (e.g., ‘Do you think X would be a good representative of your debate team?’: more weight on ‘dumb’) or not (e.g., ‘Do you think X would be a good bartender?’: both ‘dumb’ and ‘friendly’ are important). Three factors were thus manipulated in this study: valence of the target persons’ trait characteristics (univalent vs. ambivalent; task 1 and 2), having to make a choice (stimulus exposure vs. forced dichotomous choice; task 1 vs. task 2), and inconsistency resolution through evaluative context (situationally resolvable vs. situationally unresolvable ambivalence; task 2).

Figure 3.1
Graphic display of the conditions in task 1 (exposure) and task 2 (dichotomous forced choice).

Facial EMG was used to measure covert facial expressions reflecting positive (i.e. m. zygomaticus major) and negative (i.e. m. corrugator supercilli) affective responses. Overt as well as covert facial expressions of affect can be detected using facial EMG and the measure is thought to be more sensitive to weak affective responses that would be undetectable using self-report only. Positive affect, elicited by pleasant stimuli is associated with a stronger zygomaticus response, whereas negative affect, elicited by unpleasant stimuli
is associated with more corrugator activation (Brown & Schwartz, 1980; Cacioppo & Petty, 1979; Larsen, Norris, & Cacioppo, 2003). The zygomaticus is responsible for pulling the corner of the mouth back and up into a smile, whereas the corrugator lowers the eyebrows into a frown (van Boxtel, 2010). We expected ambivalent stimuli to only result in increased negative and decreased positive affect (reflected by increased corrugator and decreased zygomaticus activity) when individuals had to make a dichotomous choice and evaluative tendencies were inconsistent in the evaluative context. Likewise, we expected self-reported experienced ambivalence assessed by Priester and Petty’s subjective ambivalence scale (1996) to be dependent on whether opposing evaluative aspects were inconsistent in the current evaluative context (see Figure 3.1 for an overview of conditions and stimuli).

Method

Participants

97 undergraduates of the University of Amsterdam participated in both tasks in exchange for course credits. Only female undergraduates were recruited based on research showing that women are usually more facially reactive than men (Dimberg & Lundquist, 1990). Age of participants ranged from 17 to 25 years ($M_{age} = 20$, $SD_{age} = 1.39$). Due to electrode failure, zygomaticus major data of six participants for the first task and five participants for the second task were excluded from further analyses along with corrugator supercilii activation of eight participants for both parts of the experiment. This left us with zygomaticus major data of 91 participants for task 1 and 92 participants for task 2, as well as corrugator supercilii data of 89 participants for both tasks. The study was approved by the ethics board of the University of Amsterdam and participants gave informed consent.

EMG measurement

EMG was recorded from m. zygomaticus major and m. corrugator supercilii, both on the left side of the face using 6-mm sintered silver-silver chloride (Ag/AgCl) electrodes filled with electrode paste (Signa gel, Parker). A common ground electrode was placed on the forehead of participants at the border of the hair line. Electrodes were positioned according to standard guidelines (Fridlund & Cacioppo, 1986; Van Boxtel, 2010). Before attaching the electrodes the skin was lightly scrubbed and cleaned with alcohol. Continuous EMG recording was acquired with a custom made bipolar EMG amplifier.
with an input resistance greater than 1000MOhm and a bandwidth of 5-1000Hz. The amplification of both EMG channels was fixed at 5100x. Data acquisition was done with a NI-USB6210 device, sampling at 1000S/s. EMG data were filtered by a 50Hz notch filter and a 20-500 Hz Butterworth band-pass filter to reduce environmental noise and signal drift. EMG signal was rectified and smoothed by a contour follower with a time constant of 10ms.

**General Procedure**

The study was introduced as an electroencephalography (EEG) experiment measuring brain activation in order to prevent participants from attempting to influence their facial reactions. All participants were tested individually. E-Prime software 2.0 was used to present stimuli to participants in both tasks. The first and second task were separated by a short break to give participants some time to relax and read the instructions for the second task carefully. Different names were used to describe target persons in the first and second person perception task.

At the end of the experiment session (after task 2), we assessed individuals’ positive and negative evaluations of the different combined personality characteristics used in task 1 as well as the ones used in task 2 in a computerized post-test using an adapted evaluative space grid (Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009). The 5x5 evaluative space grid is a single-item measure of positive and negative reactions toward a particular stimulus, with *positivity* measured on the x-axis and *negativity* on the y-axis ranging from not at all (1) to very much (5). Using Thompson, Zanna, and Griffin’s (1995) formula, we combined these scores into an attitudinal ambivalence score: \((\text{Pos} + \text{Neg})/2 - |\text{Pos} - \text{Neg}|\)\(^6\). Scores on this measure can range from -1 (low attitudinal ambivalence) to 5 (high attitudinal ambivalence). For exploratory reasons, we added a single item per combination of characteristics assessing to what degree participants experienced mixed feelings and/or thoughts about that combination ranging from 0 (not at all) to 100 (very much). This item was not analysed in the current study.

**Task 1: Ambivalence exposure**

\(^6\)Pos = positive rating; Neg = negative rating
Design and Procedure

In the first task, participants were presented with a total of 24 male names that were each followed by two personality characteristics. Four positive (friendly, enthusiastic, charming, intelligent) and four negative (jealous, dominant, dumb, lazy) characteristics were combined in order to create target individuals that were described as having either two positive traits (e.g., enthusiastic, friendly), two negative traits (e.g., dumb, dominant), or one positive and one negative trait (ambivalent: jealous, intelligent). Each trial started with a fixation cross (3000ms) followed by the presentation of the name (3000ms), a fixation dot (1500ms) and subsequently the presentation of the two characteristics (each presented for 4000ms) separated by a fixation dot lasting 3000ms. Then the name was presented again (6000ms, see Figure 3.2a for a schematic overview). As we were interested in the moment that all characteristics were integrated and positive, negative, or ambivalent impression were formed, we limited analyses to the second presentation of the target name under the assumption that by then an attitude has been formed based on the previously presented characteristics. The combination of names and personality characteristics was semi-randomized across participants in that participants were randomly allocated to one of 24 different combinations of names and personality characteristics. Presentation order of the characteristics within a trial and and the presentation order of target name-trait characteristics were randomized across trials.

Data preparation: Task 1 and 2

Mean EMG signal was calculated for epochs of 500ms and a 1000ms pre-trial period was used as a baseline (see Figure 3.2). In accordance with others (e.g., Mathersul et al., 2013; Sestito et al., 2013), analyses were limited to the first 2000ms after the second onset of the target name. For each muscle separately, EMG activity was expressed as a difference score by subtracting the baseline activation (1000ms pre-trial epoch) from the 2000ms lasting activation starting at the second onset of the target name (see Figure 3.2). In order to determine extreme values, z-scores were calculated across participants and trials for each muscle over the average activation during the baseline period (1000ms) and

---

7 Translated from Dutch. Original stimuli: vriendelijk, enthousiast, charmant, intelligent, jaloers, dominant, dom, lui. Combinations were pretested (N = 30) and chosen so that are evaluated as positive, negative, or ambivalent.
average activation during target stimulus exposure (2000ms, 2nd presentation of the name/ presentation of evaluative context). A trial was excluded from analyses if its associated z-scores during target stimulus exposure or during baseline measurement exceeded a value of 3.29 based on the idea that none of the scores should yield an absolute z-score above 3.29 in normally distributed data (Field, 2013). We decided to include baseline and stimulus presentation in the outlier detection instead of change scores in order to detect extreme values present during the whole length of the trial including baseline and stimulus exposure (e.g., if participants yawn) that would not be detected by focusing on change scores alone. In the first task, 1.36% of the trials were flagged as outliers for the corrugator as well as 3.66% for the zygomaticus. In the second task, a total of 1.74% of the trials were excluded for the corrugator and 4.31% for the zygomaticus.

Figure 3.2
Schematic overview of a trial set-up. (A) Task 1. (B) Task 2.

Results and Discussion: Task 1

Manipulation check
We assessed the extent to which combinations of personality characteristics used in task 1 created univalent or ambivalent target persons after the experimental session. The different combinations of positive and negative personality characteristics manipulated attitudinal ambivalence successfully. Using Thompson et al.’s (1995) formula\(^8\) to calculate attitudinal ambivalence, we found that the combination of positive and negative characteristics elicited greater attitudinal ambivalence \((M = 2.06, SE = 0.07)\) than the combination of only positive \((M = -0.49, SE = 0.07)\) or only negative characteristics \((M = -0.31, SE = 0.08)\), \(t(96) = 26.18, p < .001\). All participants for whom data of at least one of their muscles was valid and used in subsequent analyses were included in this analysis; excluding participants for whom measures of one of the muscles were invalid yielded similar results.

**EMG response**

We compared spontaneous facial muscle activity towards ambivalent, positive and negative target persons outside of a forced choice context in order to test whether ambivalence directly evokes negative affect. EMG data were entered into two repeated-measures ANOVAs, one for each muscle, with valence (positive, negative, ambivalent) as within-participants factor.

**Stimulus exposure.**

**Zygomaticus.**

Valence of the target persons was a significant predictor of zygomaticus major activity, \(F(1.47,131.85) = 5.80, p = .009, \eta^2 = .06\) (Greenhouse-Geisser corrected). As expected, zygomaticus activity was stronger for targets described by positive \((M = 0.34\mu V, SE = 0.17\mu V)\) than negative characteristics \((M = -0.22 \mu V, SE = 0.10 \mu V)\), \(p = .006, 95\% \text{ CI for the difference [0.16, 0.96]}\), validating that the zygomaticus responds more strongly to target persons with only positive characteristics than to target persons with only negative characteristics. In line with the idea that ambivalent stimuli do not spontaneously elicit negative affect outside of a choice context, zygomaticus response to ambivalent stimuli was relatively stronger \((M = 0.02 \mu V, SE = 0.05 \mu V)\) than to negative stimuli, \(p = .028, 95\% \text{ CI for the difference [-0.47, -0.03]}\). Further supporting this idea, we found that the zygomaticus response to ambivalent stimuli did not differ

---

\(^8\) \((P + N)/2 - |P - N|\)
significantly from the response to positive stimuli, \( p = \text{ns}, 95\% \text{ CI for the difference } [-0.25, 0.66] \) (Figure 3.3a).

**Corrugator.**

The results found on the zygomaticus were mirrored by the pattern of corrugator activity. Again, the analysis showed a main effect of valence on muscle activation relative to baseline, \( F(1.68,147.44) = 7.51, \ p = .002, \ ɳ^2 = .08 \) (Greenhouse-Geisser corrected). Validating more corrugator activity with negative than with positive stimuli, we found corrugator response to be stronger for negative (\( M = 0.46, \ SE = 0.18 \)) than positive targets (\( M = -0.41 \ \mu \text{V}, \ SE = 0.17 \ \mu \text{V} \)), \( p = .003, 95\% \text{ CI for the difference } [-1.43, -0.31] \). Further support that ambivalent information is not spontaneously experienced as a negative affective event is provided by the finding that corrugator response to ambivalent stimuli (\( M = -0.22 \ \mu \text{V}, \ SE = 0.13 \ \mu \text{V} \)) was similar to the response to positive stimuli, \( p = \text{ns}, 95\% \text{ CI for the difference } [-0.59, 0.21] \), but was significantly weaker than towards negative stimuli, \( p = .002, 95\% \text{ CI for the difference } [0.25, 1.10] \) (Figure 3.3b).

![Figure 3.3](image)

**Figure 3.3**

Task 1. Facial muscle activity - muscle activity during baseline in microvolts (\( \mu \text{V} \)) during exposure to positive, negative, and ambivalent stimuli. Error bars represent standard errors. (A) Zygomaticus major (B) Corrugator supercilii. * \( p < .05 \); ** \( p < .01 \); *** \( p < .005 \)

First, bringing together results on zygomaticus and corrugator activity with univalent, positive and negative target persons, validates our paradigm. We found the expected effects of increased zygomaticus and decreased corrugator activity reflecting a positive affective response to positive target persons, and decreased zygomaticus and increased corrugator activity reflecting a negative
affective response to negative target persons. This validation shows that we can indeed measure affective responses using the current paradigm.

Second, mere exposure to ambivalent stimuli outside of a choice context, does not result in negative affect. This indicates that ambivalence is not a spontaneously negative affective experience. The data suggest that ambivalence may even elicit positive affect in the absence of evaluative response selection. Patterns of zygomaticus and corrugator activity show that affective responses to ambivalent stimuli are not distinguishable from responses to positive stimuli when participants do not have to respond to the information by making a choice.

**Task 2: Choice context**

Results of task 1 suggest that merely processing ambivalent information does not elicit negative affect. If anything, responses to ambivalent target persons were more comparable to responses to positive persons than to negative persons. Task 2 was designed to address whether a negative affective response to ambivalence is contingent on having to make a choice on the basis of inconsistent evaluations. Based on the idea that having to make a choice about ambivalent stimuli can be aversive (van Harreveld, Rutjens, et al., 2009; Chapter 2), we first expected a more negative affective response to ambivalent targets compared to positive targets as well as no difference in affective response between ambivalent and negative targets in this task.

In addition to manipulating valence of the target characteristics, we varied evaluative context in that it highlighted or resolved the inconsistency between evaluative aspects by manipulating the importance of characteristics for response selection across trials. Twenty of the 40 ambivalent trials were designed in such a way that both evaluative aspects were important for the choice and thereby created inconsistent evaluations (X is friendly and dumb: do you think X is a good bartender?) and twenty were designed so that one of the aspects was more important than the other, thereby resolving inconsistency (e.g., X is friendly and dumb: Do you think X would be a good representative of a debate team?). We predicted that the situational resolution of inconsistency would translate into a reduction of negative affect and an increase in positive affect reflected by facial EMG activation. Additionally, self-reported experienced conflict should be lower for ambivalent trials in which one of the aspects was more important for the choice at hand than for
trials in which both were equally important and pointed toward different choice options.

**Design and Procedure**

Participants proceeded with the second task after taking a short break following task 1. Trial setup was very similar to the first task, differing only in the last part of the each trial. Instead of showing target names for a second time as was done in the first task, participants were presented with a dichotomous choice question creating different evaluative contexts (e.g., ‘Would you vote for X if he was a politician?’, Figure 3.2b). The question was visible until participants gave a response with a time limit of 6000ms. Two positive (handy, friendly) and two negative characteristics (dumb, lazy\(^9\)) were combined to create one positive, one negative, and four ambivalent target persons. Participants answered the same ten questions for each person resulting in 60 trials. Questions were designed in such a way that inconsistency could be situationally resolved or not (see earlier example). Participants were instructed that there were no right or wrong answers and that we were interested in their personal opinions.

At the end of the experimental session, we measured individuals’ positive and negative evaluations of the combined personality characteristics using the evaluative grid (see *General Procedure* at the beginning of the methods section for a more extensive description of this measure). In addition, we assessed their subjectively experienced ambivalence toward each trait combination within each evaluative context using Priester and Petty’s subjective ambivalence scale (1996). This was done to assess participants’ experienced conflict (i.e. ‘discomfort’) toward each target taking into account the different evaluative contexts. The measure consists of three questions anchored with *I have completely one-sided feelings, feel no conflict, and feel no indecision* (0) and *have mixed feelings, feel maximum conflict, and maximum indecision* (100). Responses were given using a slider without numeric labels (α = .94). To facilitate the task, participants were given a sheet of paper with the characteristics of each target person so that they were not required to remember all targets and their corresponding characteristics. For exploratory purposes, participants also answered the same questions as during the

\(^9\) Translated from Dutch. Original stimuli: handig, vriendelijk, lui, dom.
experiment using a slider instead of a dichotomous choice. This measure was not included in the analyses of the current study.

**Results and Discussion: Task 2**

**Manipulation check**

On the basis of Thompson et al.’s ambivalence formula (1995), attitudinal ambivalence scores were calculated from participants’ positive and negative evaluations of the combinations of the four personality characteristics. The results show that the manipulation of attitudinal ambivalence was successful. As expected, attitudinal ambivalence for combinations of positive and negative characteristics was higher ($M = 2.10$, $SE = .08$) than for combinations that were only positive ($M = -0.26$, $SE = .13$) or only negative ($M = -0.64$, $SE = .09$), $t(96) = 21.82$, $p < .001$. All participants for whom at least one of their muscle activation measures were valid and used in subsequent analyses were included in this analysis; excluding participants for whom measures of one of the muscles was invalid yielded similar results.

**EMG response**

**Choice context.**

*Zygomaticus.*

To assess the effect of informational valence on zygomaticus activity in a forced choice situation, we ran a repeated measures ANOVA with valence (positive, negative, ambivalent) as a within-subject factor. As in task 1, zygomaticus activation was reliably predicted by valence of the target, $F(1.76,160.25) = 3.37$, $p = .04$, $η^2 = .04$. In contrast to task 1, muscle activation during the forced choice about ambivalent targets ($M = -0.41 \mu V$, $SE = 0.05 \mu V$) did not differ from activation during the choice about negative targets ($M = -0.35 \mu V$, $SE = 0.06 \mu V$), $p = ns$, 95% CI for the difference [-0.21, 0.09]. However, making a choice about ambivalent targets led to a greater decrease in zygomaticus activation than judging positive targets ($M = -0.18 \mu V$, $SE = 0.09 \mu V$), $p = .016$, 95% CI for the difference [0.04, 0.41]. Also, note that zygomaticus activation was negative compared to baseline, showing an overall relative decrease in positive affect during the choice task (Figure 3.4A).

*Corrugator.*
Surprisingly, activity of the corrugator was not predicted by valence of the target persons in a forced choice situation, \( F < 1, p = \text{ns} \). In that corrugator showed relatively high levels of activation during task 2 compared to baseline activation (see Figure 3.4) and that mental effort leads to greater corrugator activity (Van Boxtel & Jessurun, 1993), the absence of a valence effect might have occurred because participants exerted more effort making choices in task 2. This may have overshadowed the effect of affective valence observed in zygomaticus activity and found on both muscles in task 1.

**Figure 3.4**
Task 2. Facial muscle activity - muscle activity during baseline in microvolts (µV) during evaluation of positive, negative, and ambivalent stimuli. Error bars represent standard errors. (A) Zygomaticus major (B) Corrugator superciliii. + \( p = .11 \); * \( p < .05 \); ** \( p < .01 \)

**Exposure vs choice.**

To assess the effect of having to make a choice on the affective response to ambivalent stimuli, we compared zygomaticus and corrugator activity between task 1 and task 2. As both tasks were conducted among the same participants we conducted paired t-tests on zygomaticus and corrugator activity with task (stimulus exposure vs. forced choice) as within-subject factor. Note, however, that besides changing that participants had to respond to the stimuli by making a choice in the current task, the procedures of the two tasks were also slightly different in that stimuli in task 2 were each repeated ten times in combination with 10 different evaluation contexts compared to task 1 in which each stimulus was only presented once. Affective responses to ambivalent stimuli indicated by both zygomaticus and corrugator activity differed significantly between the two tasks. As predicted,
participants showed less zygomaticus activation as a response to ambivalent stimuli when they had to make a choice about the stimulus ($M = -.41\mu V$, $SE = .05 \mu V$) compared to when they did not have to make a choice ($M = .02 \mu V$, $SE = .05 \mu V$), $t(90) = 6.006$, $p < .001$. Consistently, participants displayed more corrugator activation as a response to ambivalent stimuli when they had to make a choice about the stimulus ($M = .53 \mu V$, $SE = .10 \mu V$) compared to when they did not have to make a choice ($M = -.22$, $SE = .13$), $t(88) = -4.841$, $p < .001$. These results support our interpretation that having to make a choice is necessary for showing less positive and more negative affect as a response to processing ambivalent information.

**Situational resolution of inconsistency: choice conflict.**

Based on the idea that ambivalence only elicits negative affect if it creates a choice conflict due to inconsistent evaluations, another objective of the second task was to assess the effect of situational resolution of inconsistency on the direct affective response to ambivalent information and the experience of conflict (i.e. discomfort). To assess whether we successfully manipulated the possibility to situationally resolve choice conflict we first looked at participants’ self-reported conflict about the three different stimulus types (univalent, situationally resolvable ambivalent, situationally unresolvable ambivalent). As expected, we found an overall effect of stimulus type on subjectively experienced ambivalence, $F(1.38, 132.74) = 230.86$, $p < .001$, $\eta^2 = .71$ (Greenhouse Geisser-corrected). Subjectively experienced ambivalence about univalent target persons ($M = 9.87$, $SE = .87$) was lower than experienced ambivalence about situationally resolvable ambivalent targets ($M = 28.33$, $SE = 1.54$), which was significantly lower than experienced ambivalence about situationally unresolvable ambivalent targets ($M = 37.40$, $SE = 1.59$), all $p’s < .001$ (Bonferroni-corrected). The possibility to resolve inconsistency in the evaluative context thus significantly lowered participants’ self-reported experience of conflict, yet participants still experienced more conflict for situationally resolvable ambivalent stimuli than univalent stimuli.

Whereas the self-report measures indicated that situational resolution of inconsistent evaluations indeed lowers discomfort that participants experience in response to ambivalent information in a choice situation, we were also interested in the effect of evaluative context on direct affective responses to ambivalent stimuli. To test the more direct effect of situational resolution of inconsistencies, we looked at the zygomaticus response within
the first 500ms\textsuperscript{10} after stimulus presentation across the three stimulus types (univalent, situationally resolvable ambivalent, situationally unresolvable ambivalent). Mirroring the results on self-report measures, this analysis revealed that even within the first 500ms after stimulus exposure we found an overall effect of stimulus type on zygomaticus response, $F(1.81, 164.42) = 3.92, p = .026, \eta^2 = .04$ (Greenhouse-Geisser corrected). Zygomaticus activation to situationally resolvable ambivalent stimuli was similar to activation to univalent stimuli, $p = \text{ns}$, 95% CI for the difference [-0.13, 0.13]. Additionally, zygomaticus showed decreased activation when processing situationally unresolvable ambivalent stimuli ($M = -0.42 \mu V, SE = 0.07\mu V$) than when processing situationally resolvable ambivalent stimuli ($M = -0.23\mu V, SE = 0.05\mu V$), $p = .02$, suggesting that relatively spontaneous affective responses are influenced by the possibility to resolve conflict within a current situation. When evaluative context helped resolve ambivalence and evaluations were thus consistent, participants displayed greater zygomaticus activation showing relative more positive affect than when context did not help resolve ambivalence (and evaluations were inconsistent). This indicates that situational resolution of ambivalence may appear as quickly as 500ms after stimulus presentation.

Summing up, affective responses to ambivalent stimuli in a forced dichotomous choice context in which both attitude components are relevant and thus inconsistent resemble responses to negative stimuli. We found a decrease in zygomaticus activity compared to baseline for negative and ambivalent stimuli compared to positive stimuli. This effect was qualified by the possibility to resolve inconsistency between evaluations in the choice situation. If the evaluative context helped resolve inconsistency for ambivalent evaluations, participants reported lower levels of self-reported of ambivalence experience and showed altered affective responses to ambivalent information assessed by zygomaticus activation when having to make a choice. Within 500ms after stimulus onset, zygomaticus activation was stronger for situationally resolvable than unresolvable ambivalent evaluations.

**General Discussion**

\textsuperscript{10} Based on the recorded data, this was the shortest time window in which our data could be analyzed. Data from the corrugator were not analyzed because no effect of valence was found on the corrugator in task 2.
In the current paper we shed further light on the affective response to ambivalence and identified that affective responses to ambivalence are context-dependent. Ambivalence elicits relatively more negative affect when the inconsistency of ambivalent evaluations creates a choice conflict. First, results suggest that ambivalent information in the absence of a forced choice situation elicits the same direct affective response as positive stimuli; participants showed more zygomaticus and less corrugator activation than to negative stimuli. Second, we found that processing ambivalent information in a forced choice context, led to a relative decrease in positive affect. Even though earlier research focused mostly on an increase in negative affect as a response to ambivalence (Hass et al., 1992; van Harreveld, Rutjens, et al., 2009), no effect was found on negative affect assessed by corrugator activity. Third, we found that affective responses to ambivalence when a choice had to be made were influenced by evaluative context. Specifically, ambivalence only led to a relative decrease in positive affect when evaluative context did not help resolve the inconsistency between ambivalent evaluations and created a choice conflict. When the same ambivalent information was presented in a context in which the opposing evaluations were not logically inconsistent (i.e. one of the characteristics was more relevant for response selection than the other and inconsistency was temporarily resolved), participants reported to experience lower levels of conflict and displayed less negative affect. The possibility to resolve ambivalence affected facial muscle activation within 500ms after stimulus presentation. Overall, the pattern of results seems to suggest that ambivalent evaluations have to be inconsistent in the current choice situation in order to elicit negative affect (i.e. a relative decrease in positive affect). The discussion below is structured along the order of these findings.

First, results support the idea that ambivalent stimuli do not spontaneously trigger a negative affective response, but that response selection is necessary for ambivalence to be experienced as less positive. This finding corresponds with earlier studies showing an increase in physiological arousal due to ambivalence only when participants had to make a choice about the topic and not when they could express a balanced opinion (van Harreveld, Rutjens, et al., 2009). Notably, when ambivalence did not have to be responded to (Task 1), affective responses to ambivalent information were even similar to responses to positive information. Two explanations can be given for this finding. First, situations and stimuli that are relatively neutral are generally
evaluated more positively (positivity offset; Ito & Cacioppo, 1996). Similarly, most people report to feel happy, or positive in the absence of major, negative events (Diener & Diener, 1996). Possibly not only neutral information, but also information that contains positive and negative information is subject to a positivity offset if ambivalence is not evaluatively relevant. In general, ambivalent information thus does not lead to an additive effect of positivity and negativity on affect, but there is a tendency to experience more positive than negative affect when merely exposed to ambivalent information.

Second, the results show that ambivalence is affectively more negative when a choice has to be made. Only in these cases, the facial muscle response to ambivalent information was comparable to the response to negative information, indicating less positive affect (decreased zygomaticus activity) compared to positive stimuli. These results challenge previous explanations stating that ambivalence is experienced as unpleasant due to the violation of a fundamental motive to be consistent in thoughts, feelings, and behavior (McGregor et al., 1999). If a fundamental consistency motive was the sole reason for negative affect under ambivalence, then exposure to ambivalent information (task 1) should have resulted in more negative affect than univalent, positive information. This is, because ambivalent information by itself constitutes an inconsistency in that the stimulus is evaluated positively and negatively at the same time. Possibly, inconsistent information has to be interpreted as relevant in order for inconsistencies to be acknowledged and responded to. This finding supports Schacht et al.’s (2010) suggestion that conflict may only elicit a negative affective response if made relevant by context. This makes sense in an energy-conservation modality, in that individuals are unwilling to spend energy on either affective processes or solving inconsistencies that are irrelevant in a current situation. However, even though the ambivalent information we presented in the first task created an overall ambivalent, and thus inconsistent evaluation of the target persons, the evaluative aspects themselves were not logically inconsistent outside of a choice context. To be certain that inconsistent evaluations do not elicit more negative affect if they do not create a choice conflict, future studies should assess the effect of opposingly valenced evaluative aspects that are inconsistent even outside of an evaluative context (e.g., “Bob is friendly and Bob is cold”).
Third, the effect of choice was qualified by the evaluative context in which ambivalent information was presented. By emphasizing the importance of both evaluative aspects or emphasizing one evaluative aspect over the other, evaluative context either highlighted or helped resolved the inconsistency among evaluations. We found that situational resolution of inconsistency in a forced choice situation resulted in lower self-reported experienced conflict and influenced zygomaticus activation directly after exposure to the ambivalent information. Participants showed more positive affect when ambivalence was situationally resolvable compared to when it was not. Interestingly, this effect on zygomaticus activation appeared within 500ms after presenting ambivalent information in a resolving context, suggesting that a negative response to ambivalent information did not develop or was down-regulated quickly. Using single-neuron recordings, Kawasaki and colleagues (2001) found that negative valence can be processed within 120-160ms after stimulus presentation, so that ambivalence may have been detected and subsequently been downregulated within the time window in which we have measured zygomaticus activation. Additionally, based on Sroufe and Water’s (1976) hypothesis that laughter is a consequence of tension release, Rotteveel and Phaf (2012) suggested that a quick resolution of conflict, or even the possibility to resolve conflict, results in positive affect. Further research will have to show how the affective response to conflicting stimuli develops within this time window after stimulus exposure in order to determine whether negative affect is prevented or down-regulated by situational information that helps resolve conflict. This should also further clarify whether decreased zygomaticus activation is either a reflection of positive affect as a response to conflict resolution, or a reflection of a decrease in negative affect (see below). In addition, neuroimaging research may be able to shed light on this issue by comparing networks involved when processing situationally resolvable ambivalent information with univalent information. It could be that if an evaluative context makes one evaluative aspect more relevant than the other, there are essentially no differences in the processing of and responding to ambivalent and univalent information. If evaluative context prevents evaluative conflict, this should, for example, be reflected in similar activation levels of regions related to conflict-processing (e.g., ACC) when processing univalent and situationally resolvable ambivalent information. However, if evaluative context helps resolve conflict after ambivalence has been detected, we should be able to distinguish processing of
univalent and situationally resolvable ambivalent information on a neural level.

Whereas processing ambivalent information led to a decrease in positive affect reflected by lower zygomaticus major activation when individuals had to make a dichotomous choice, no effect of informational valence was found on the corrugator in task 2. This was surprising as other research has mostly focused on an increase in negative affect as a response to conflict (cf. Dreisbach & Fischer, 2012; Festinger, 1957; Botvinick et al., 2001; van Harreveld, Rutjens, et al., 2009). However, also in other impression formation tasks the zygomaticus has been found to respond more reliably than the corrugator, and as a consequence it has previously been used as an index for negative affect in these tasks (e.g., Vanman, Saltz, Nathan, & Warren, 2004). In a study on racial prejudice, for example, Vanman and colleagues (2004) reported that greater zygomaticus (and not corrugator) activity when viewing White compared to Black faces, was related to greater racial bias in a fictitious job selection procedure, suggesting more discomfort when viewing Black than White faces. It may be that smiling is the default response in social interaction, so that mild negative affect is more likely to be expressed by a relaxation of the zygomaticus major. This is also supported by the positivity offset reported earlier, in that the default response to ambivalent stimuli was similar to the response to positive stimuli. Alternatively, it could be that the lack of an effect on the corrugator in our second task may be due to cognitive load, in that participants had to process additional information (choice options) as well as weigh this information in order to make a choice. EMG amplitude in the corrugator superciliii is known to also respond to mental effort and task difficulty (van Boxtel & Jessurun, 1993). As suggested above, the absence of an effect of valence in the choice task may be due to greater mental effort that is exerted in the task itself compared to baseline, thus possibly overshadowing the effect of valence. The zygomaticus major, on the other hand, is known to respond only little to mental effort and task load (e.g., van Boxtel & Jessurun, 1993), so that affective responses to the stimuli may mostly be mirrored in zygomaticus major activation in the more mentally taxing, second task.11

11 Additionally, Hormes and Rozin (2011) reported that positive affect decreased after participants had consumed chocolate, a food item most people are ambivalent about, whereas negative affect stayed constant over time. Further research will have to show whether negative affective responses,
The fact that we find decreased zygomaticus activity during processing of ambivalent information in a situation of choice conflict and that the zygomaticus responds only little to mental effort (van Boxtel & Jessurun, 1993; Waterink & van Boxtel, 1994) also shows that the change in affective response to ambivalence is not due to processing a more complex evaluation per se, or due to forcing participants to resolve ambivalence in the forced choice paradigm. Processing complexity and accompanying mental effort are often suggested as alternative explanations for negative affective responses to ambivalent and other conflicting stimuli, and research has proven it difficult to disentangle complexity and ambivalence. This is because ambivalent evaluations are by definition more complex than univalent evaluations, because they cannot be easily combined into a straightforward, one-sided behavioral response. Whereas several positive or several negative evaluations can easily be translated into a single-factor solution (Bob is intelligent and friendly: I like Bob), this is not the case for ambivalent evaluations (Bob is charming and dumb: I like and dislike Bob) and complexity is thus an inherent feature of these evaluations. The current results suggest though that complexity and mental effort that accompany processing ambivalent information in a forced choice context are not by themselves responsible for the more negative affective response to ambivalence.

Overall, our results show that processing ambivalent information need not always elicit negative affect. On the contrary, individuals processing ambivalent information outside of a choice context even showed more positive affect compared to individuals processing negative information. Our findings may offer an explanation for previously reported inconsistent results of self-reported experience of conflict and negative affect as a consequence of ambivalence. The current study shows that observed affective responses to ambivalence are dynamic and depend on situational construal and whether inconsistent evaluations create choice conflict. This suggests that depending on the circumstances, measurement and timing of the measurement, reported affective responses to ambivalence may be very different. If current goals (e.g., a positive self-presentation in a social context) suggest that evaluative conflict is desirable because it represents a balanced attitude (Maio et al, 2001; Pillaud, Cavazza, & Butera, 2013), for example, evaluative conflict may elicit positive or discomfort, caused by ambivalence may be due to a decrease in positive rather than an increase in negative affect.
instead of negative affect since it resolves the negativity of inconsistent evaluations (e.g., “I want to have an opinion that people can agree with, so liking and disliking Bob is fine.”). However, if being ambivalent represents something undesirable (e.g., being prejudiced in a racial context; cf. Hass et al., 1992) or creates a choice conflict, ambivalence may elicit relatively more negative affect. All in all, this suggests that dependent on whether opposingly valenced evaluations are interpreted as inconsistent in the current evaluative context, ambivalent stimuli may elicit negative, or positive affect.
Chapter 4

Resolving ambivalence in context:
Neural responses to ambivalent information are also shaped by evaluative context.

This chapter is based on:

We thank Michiel van Elk for his assistance during data collection, as well as the members of the Social Cognitive Science Lab at the University of Toronto for their helpful comments on earlier versions of this manuscript.
Evaluations of our environment provide us with essential information that guides our behavior. Positive evaluations of an object, person, or situation suggest that it may be advantageous to approach and explore, whereas negative evaluations suggest that one might want to avoid or attack the source of evaluation (Chen & Bargh, 1999; Darwin, 1872). Although evaluations can be quick and efficient, they require considerably more effort when associations with a stimulus are positive and negative, thus forming an ambivalent attitude (Cacioppo & Berntson, 1994; Kaplan, 1972; Newby-Clark, McGregor, & Zanna, 2002; Priester & Petty, 1996; Thompson, Zanna, & Griffin, 1995; van Harreveld, van der Pligt, de Vries, Wenneker, & Verhue, 2004). An ambivalent attitude (structural ambivalence) is the prerequisite for experienced ambivalence, which develops when competing stimulus associations are simultaneously active and cannot easily be resolved (cf. Cunningham, Zelazo, Packer, & van Bavel, 2007; Priester & Petty, 1996; van Harreveld, Nohlen, & Schneider, 2015; van Harreveld, Rutjens, Rotteveel, Nordgren, & van der Pligt, 2009; van Harreveld, van der Pligt, & de Liver, 2009). Whereas an ambivalent attitude thus refers to the existence of opposing associations, experienced ambivalence refers to the subjective experience of conflict due to attitudinal ambivalence.

Processing ambivalent information is more complex than processing univalent information. This is especially the case when ambivalence has to be resolved in order to derive a single-factor solution, for example when having to make a dichotomous choice (i.e., positive or negative, approach or avoid; Cunningham et al., 2007; van Harreveld, Rutjens et al., 2009). Consistently, neuroimaging studies have shown that processing ambivalent information in order to make such a valence-based choice (good/bad; for/against) engages a broad network of regions including the anterior cingulate cortex (ACC), ventrolateral prefrontal cortex (vLPFC), posterior cingulate cortex (PCC), precuneus, temporal parietal junction (TPJ), as well as the insula (Chapter 2; Cunningham et al., 2003; Jung et al., 2008). This is contrary to deriving valence-based judgments from univalent information, which does not result in any additional activation compared to processing ambivalent information in the same task (Chapter 2). In cases when ambivalent information has to be integrated to make a valence-based choice, evaluative context or task goals can often help reduce and even temporarily resolve conflict (Chapter 3; Cunningham et al., 2007). Consider your evaluation of Joe, who has positive (e.g., he is intelligent) and negative characteristics (e.g., he is dominant). As a
result, your attitude toward Joe consists of positive (intelligent) and negative (dominant) associations, i.e. it is ambivalent. Depending on the context in which the information is evaluated, the inconsistency between opposingly valenced evaluations (i.e. “Joe is positive and Joe is negative”) may be solved (“Can Joe write a good research article?”) by emphasizing some information (“Joe is intelligent”) or suppressing other information (“Joe is dominant”). In this case, even though the attitude is ambivalent and the overall evaluation of Joe is inconsistent, competition between evaluative tendencies is resolved quickly and making a choice can become relatively simple (Chapter 3). However, if the context does not allow shifting the relevance of one type of evaluative tendency (e.g., “Do you think Joe is a good collaborator?”), both competing tendencies create choice conflict and thus make it more difficult to come to a unitary judgment. In this case, positive and negative associations both remain important for the evaluation and individuals experience ambivalence and negative affect. Despite depending on the same associative structure of the attitude representation and thus having the same structural complexity, less conflict is experienced in the former compared to the latter evaluation of Joe. This is also reflected in greater zygomaticus activation when processing ambivalent information for which conflict is situationally resolvable than ambivalent stimuli for which this is not the case (Chapter 3). What remains unknown is how evaluative context influences processing of ambivalent information. Resulting from the findings reported in Chapter 3, we have posed the question whether evaluative context can prevent the development of evaluative conflict and situationally resolvable ambivalent information is essentially processed similarly to univalent information, or whether evaluative context can help resolve conflict after ambivalence has been detected. Neuroimaging may shed some light on this issue, and in the current study we aim to investigate how situational resolution of ambivalence is reflected in the activation of different brain regions.

4According to the Iterative Reprocessing Model of Evaluation (IR Model; Cunningham & Zelazo, 2007), evaluative information is interpreted and re-interpreted until a motivationally sufficient evaluation has been reached. Across these evaluative cycles, evaluations can become more complex and engage more higher-order regions. A satisfactory evaluative response is reached relatively quickly and easily if the attitude is unconflicted (univalent), because initial evaluations suggest a clear behavioral strategy which may subsequently be confirmed in higher-order processing. However, if the
attitude is ambivalent, initial evaluative tendencies are conflicted and leave decisional uncertainty. According to the IR Model, current situational affordances and goals (i.e. evaluative context) may allow shifting the relevance of different associations by emphasizing some parts of the evaluation and suppressing others (Cunningham & Zelazo, 2007; Cunningham et al., 2007; O’Reilly & Munakata, 2000). This may be done, for example, by focusing attention on positive aspects and ignoring negative ones. Evaluative context can thus help reduce inconsistency between evaluative tendencies by biasing subsequent evaluations and eventually behavioral output (Figure 4.1).

**Figure 4.1.**
Evaluative processing of ambivalent information in line with context.

This model of evaluative processing has certain implications regarding the question posed at the beginning of this chapter. As current context and goals are thought to influence later evaluative cycles (Cunningham et al., 2007), processing of ambivalent stimuli should be distinguishable from processing of univalent stimuli even if evaluative context helps resolve ambivalence. The IR Model makes predictions about certain brain regions involved in this process, yet does not make predictions about others (e.g., insula, TPJ) that we have found more activated during processing of ambivalent than univalent information in a choice context. A key region suggested to be involved in the detection of evaluative uncertainty is the ACC, which communicates the need for additional reprocessing of the stimulus (cf. Botvinick, 2007). Signals of this
region may then be relayed to the lateral prefrontal cortex (lPFC), where evaluative uncertainty is attempted to be reduced by forming increasingly complex evaluations (Nakao et al., 2010; Kerns et al., 2004; Ridderinkhof, Ullsperger, Crone, & Nieuwenhuis, 2004). Whether ambivalence is experienced as a state of conflict (choice conflict in this case) depends on whether reprocessing of the stimulus can resolve evaluative competition by taking current context and goals into account (cf. Cunningham & Zelazo, 2007).

Based on our findings from Chapter 2, next to regions suggested by the IR Model, we may also find increased involvement of the PCC/precuneus, TPJ, and insula when individuals attempt to resolve ambivalence. Especially the PCC may play an important role based on studies suggesting an engagement of the PCC when expectations are violated (Du, Hitchman, Yhang & Qiu, 2014) that ask for a change in behavioral strategies (Leech, Braga, & Sharp, 2011). PCC and ACC may thus be similarly engaged as both signal the need to change processing strategies. The insula may be mostly engaged when evaluative context cannot help resolve ambivalence, mirroring the negative affective response to unresolvable evaluative conflict in a choice situation (Chapter 3). In Chapter 2, we have also found the TPJ to be more activated when processing ambivalent compared to univalent information. The TPJ has been linked to Theory-of-Mind tasks, in which individuals infer other people’s beliefs and intentions by taking another person’s perspective (Saxe, 2010). Others have found that the TPJ is also engaged by attentional tasks, for example, when distracting stimuli are presented that share a salient, perceptual feature (e.g., color) with a particular target stimulus (Serences et al., 2005). This has been interpreted as the TPJ playing a role in selectively shifting attention from task-irrelevant to relevant features. The role of the TPJ may thus be dependent on task features and we did not have any specific predictions about its differential engagement during processing of resolvable or unresolvable conflict.

In this chapter, we tested the influence of evaluative context in processing ambivalent and univalent information on behavioral (response times) and neural level using a similar person perception paradigm as in Chapter 3. Our predictions were three-fold. First, the necessity to engage in more evaluative cycles for processing of ambivalent information and the idea that evaluative context reduces (instead of prevents) conflict by influencing later evaluations
suggests an increase in response times from choices about univalent, to situationally resolvable to situationally unresolvable ambivalent choices (univalence < situationally resolvable ambivalence < situationally unresolvable ambivalence). In line with our finding that the affective response to making a choice on ambivalent information is only more negative compared to univalent information if the inconsistency between evaluations remains unresolved (Chapter 3), we may obtain stronger insula activation only when evaluative context cannot help resolve inconsistency (univalence = situationally resolvable ambivalence < situationally unresolvable ambivalence) due to the insula’s assumed role in the experience of negative emotional states (Critchley, Elliott, Mathias, & Dolan, 2000). Finally, we may find evidence for increased engagement of ACC, lateral PFC, and PCC from choices about univalent to situationally resolvable and situationally unresolvable ambivalent stimuli (univalence < situationally resolvable ambivalence < situationally unresolvable ambivalence). ACC, usually associated with conflict detection and monitoring (e.g., Botvinick et al., 2004; Bush et al., 2000) is suggested to signal the presence of opposingly valenced (i.e. ambivalent) evaluations and initiate additional prefrontal processing. PCC and precuneus have been linked to signaling the need for a change in behavioral strategies and changing the focus of attention (Leech & Sharp, 2014). In line with the IR model, which suggests that evaluative context is used in later evaluative cycles (Cunningham et al., 2007), greater ACC and PCC/precuneus activation for ambivalent information may initially be independent of the possibility to resolve inconsistency and thus also be present for ambivalent stimuli if inconsistency is situationally resolvable. Medial and lateral prefrontal regions are suggested to reprocess evaluative information and use evaluative context in order to resolve conflict. Re-evaluation of the stimulus within its context can either prevent or elicit a state of experienced ambivalence. If re-evaluation does not alleviate conflict, individuals experience ambivalence and conflict reflected in even greater ACC and PCC activity, initiating further re-evaluations of the stimulus.

**Materials and Methods**

**Participants**

Participants were 20 current and former students of the University of Amsterdam and the Amsterdam College of higher education in the Netherlands (11 male, 9 female) in the age range of 18 to 29 years (M = 22.7,
$SD = 2.60$). Participants provided informed consent, had normal or corrected-to-normal vision and none of them had a history of neurological problems. 19 of 20 participants were right-handed. All procedures were approved by the ethical committee of the University of Amsterdam.

**Design and Procedure**

Two to five days before the scanning session, participants received descriptions of four male individuals (Tom, Fred, Bob, and Jan$^{12}$). The descriptions consisted of a list of four traits and a short text to make the traits more memorable for the individual. Based on the traits, one individual was described as positive (friendly, charming, enthusiastic, intelligent$^{13}$), one as negative (dominant, jealous, lazy, dumb), and two had mixed characters (dominant, jealous, enthusiastic, intelligent; friendly, charming, lazy, dumb). The combinations of names and characteristics were counterbalanced across participants and we used a pilot test ($N = 34$) to ensure that the trait combinations were interpreted as positive, negative, or ambivalent. Participants were asked to memorize the combinations before the scanning session and were tested on how well they remembered the combinations before entering the scanner. If participants were not able to freely recall the characteristic of the four individuals at the beginning of the experiment, they were again given time to learn them. All participants were able to quickly recall the combinations at the beginning of the scan session.

**fMRI choice task.**

Participants made dichotomous (yes/no) choices about the four target persons in 21 different evaluative contexts (see Chapter 3 for a similar design). All evaluative contexts were presented randomly in combination with all four target persons (84 trials in total). Based on the pretest we expected these contexts to vary in the degree to which they resolved the inconsistency between evaluative tendencies for ambivalent targets by altering the importance of characteristics for the choice participants had to make. An example of an item that helps resolve inconsistency between evaluative tendencies and thus elicits relatively low levels of experienced ambivalence would be: X is intelligent and dominant. “Do you think X can write a good

---

$^{12}$ Jan is a male name in Dutch.

$^{13}$ Stimuli are translated from Dutch.
research article?”. For the same characteristics, the question “Do you think X would be a good collaborator?” would elicit greater levels of experienced ambivalence. To account for differences in the positive and negative weight that individuals give to particular traits in each evaluative context, participants’ subjectively experienced ambivalence to the combination of question and target traits was assessed in a post-test. This measure was used to categorize ambivalent trials into trials that represented situationally resolvable and situationally unresolvable ambivalent trials for each participant individually (see below for a more detailed description).

In the scanner, participants indicated their choice (“yes”, “no”) on each question by pressing one of two buttons with their right index and middle finger. Choice labels were counterbalanced, so that half of the participants responded ‘yes’ with their index finger and half of the participants responded ‘no’ with their index finger. The order of questions (i.e. evaluative contexts) and target persons was randomized and participants were given a 5 s break after every 21 trials. Trials started with a fixation cross (500ms), and questions were presented until participants made a response. After the response we presented a white dot on a black screen with varying presentation times (min. = 4000ms, max. = 6600ms) before starting the next trial (Figure 4.2).

**Ambivalence measures.**

**Pretest: ambivalence toward the target persons.** Attitudinal ambivalence toward the four target persons was assessed before the scanning session in two ways. Participants evaluated all four individuals on Priester and Petty’s subjective ambivalence scale (1996). The scale consists of three items and aims to measure the affective, cognitive, and behavioral components of ambivalent attitudes. The three items were anchored with “Toward this person I...” have completely one-sided feelings, feel no conflict, and feel no indecision (0) and have mixed feelings, feel maximum conflict, and maximum indecision (100). Participants responded on a slider without numeric labels (α = .71). Ambivalence was determined by taking the mean of these three questions. Additionally, participants rated how positively (negatively) they evaluated each targets’ most positive (negative) traits on a scale ranging from not at all (0) to very (100). These positive and negative ratings were combined using Thompson et al.’s (1995) formula: $\text{Ambivalence} = (\text{Pos} + \text{Neg})/2 - |\text{Pos-Neg}|$. 
Figure 4.2.
(A) Timing sequence of an experimental trial, (B) Example trial for each stimulus type.

Posttest: experienced ambivalence toward each target person in each evaluative context. After scanning, participants rated each question (i.e. combination of target person and evaluative context) presented in the scanner on the subjective ambivalence scale (Priester & Petty, 1996) by stating to what degree they had mixed feelings, felt conflict, and felt indecisive about each question that was presented (e.g., “I have mixed feelings/feel conflict/feel indecision about X being able to write a good research paper”). Equivalent to the pretest, responses were given on a slider (0-100) without numeric labels (α = .93). Based on the mean of these three questions, we could differentiate trials in which the conflict between ambivalent evaluations could be resolved from trials in which conflict between competing evaluative tendencies could not be resolved and participants were presented with a choice conflict. As participants were presented with 21 trials about each target, for each participant and target person described by ambivalent traits, the 11 highest scoring ambivalent trials on the posttest subjective ambivalence measure were
categorized as situationally unresolvable ambivalence trials and the 10 lowest as situationally resolvable ambivalence trials. This was done for both ambivalent target individuals, so that we had 22 situationally unresolvable ambivalent trials and 20 situationally resolvable ambivalent trials per participant. To account for individual variation, categorization of trials was done on participant level instead of across participants (see above). For exploratory reasons, participants also responded to the same questions that were presented in the scanner in a continuous manner ranging from definitely not (0) to definitely yes (100). This second measure was not analyzed for this study.

Ambivalence measured toward the target person in general (pretest) served as the measure of attitudinal ambivalence (i.e. conflict) toward the person, and ambivalence toward the target person in a particular evaluative context (posttest) indicated the degree to which conflict for ambivalent target persons could be resolved in each evaluative context, where higher scores indicated more experienced conflict (situationally unresolvable ambivalence) and lower scores indicated less experienced conflict (situationally resolvable ambivalence). The same scale was used for both measurements to ensure that any obtained effects would not be due to different measurements of ambivalence. In the following, we will thus use the term *attitudinal ambivalence* to refer to the ambivalence toward the person as measured in the pretest, and *experienced ambivalence* to refer to the ambivalence toward the target person in the evaluative context (posttest).

There were thus three critical stimulus types: univalent (42 trials), attitudinally ambivalent stimuli for which evaluative context could help resolve ambivalence (low experienced ambivalence; 20 trials), and attitudinally ambivalent stimuli for which context could not help resolve ambivalence (high experienced ambivalence; 22 trials).

**MRI Data Acquisition**

Imaging was conducted with a 3.0 Tesla Philips Achieva scanner at the Spinoza Centre for Neuroimaging in Amsterdam. Head motion was limited to a minimum by placing foam inserts around the head inside the head coil. Stimuli were presented using E-Prime and projected onto a screen in the magnet bore which participants could see through a mirror attached to the head coil. The task consisted of one event-related run, lasting approximately
12 minutes. Functional data were obtained using T2*-weighted echo-planar imaging (EPI). The first 2 dummy scans were removed to allow for equilibration of T1 saturation effects (Time repetition (TR) = 2 sec, Time Echo (TE) = 28ms, voxel size 3 x 3 x 3 mm). A high-resolution T1-weighted sagittal scan was collected as anatomical reference (TR = 9.56; TE = 4.6, voxel size 1.2 x 1.2 x 1.2).

**fMRI Processing**

Data were preprocessed and analyzed with FSL (FMRIB’s Software Library, www.fmrib.ox.ac.uk/fsl). Using FSL default settings, data were corrected for motion, and spatially smoothed using a Gaussian kernel of FWHM 5 mm. We applied a highpass temporal filter (Gaussian-weighted least-squares straight line fitting, with sigma = 50s). Images were registered to high resolution structural and standard space images using FLIRT. The data were modeled by a series of events convolved with a hemodynamic response function (HRF). Trials were modeled based on the onset of stimulus presentation. The trial functions were used as covariates in a general linear model, along with a basic set of cosine functions to high-pass filter the data. We used a corrected cluster significance threshold of $p = 0.05$ and determined clusters by $Z > 2.3$ to threshold the Z statistic images (Worsley, 2001).

We modeled the BOLD response by the four target persons (positive, negative, and two ambivalent targets). For each ambivalent target person, trials were categorized as eliciting low (situationally resolvable ambivalence) or high levels of experienced ambivalence (situationally unresolvable ambivalence) based on the individual median split of participants’ ambivalence score about each presented trial (posttest, see above for a more detailed description). This was done in order to separate activation on the basis of context-dependent resolution of ambivalence. Filler trials (5 sec breaks after every 21 trials) were entered as nuisance regressors.

**Results**

**Behavioral Results**

**Pretest.**

Two separate ratings for attitudinal ambivalence toward the four target persons, independent of evaluative context, were assessed in the pretest. First, we computed ambivalence to each of the targets by taking the mean of
participants’ self-reported conflicting thoughts, indecisiveness, and mixed feelings about the target persons (cf. Priester & Petty, 1996). A dependent t-test comparing the ambivalence scores for the univalent with the ambivalent targets confirmed that participants experienced less ambivalence about the former \((M = 11.03, SE = 2.24)\) compared to the latter targets \((M = 40.67, SE = 3.13)\), \(t(19) = -8.610, p < .001, r = .89\). We also calculated an ambivalence score on the basis of the positivity and negativity ratings for each of the four target individuals using Thompson et al.’s (1995) formula \(^{14}\). As expected, ambivalence was significantly higher for the two individuals described by mixed characteristics \((M = 48.05, SE = 4.61)\) than the two individuals with only positive or negative characteristics \((M = -30.21, SE = 5.14; t(19) = -9.405, p < .001, r = .91)\). Both results confirmed that our manipulation of attitudinal ambivalence was successful.

**Posttest.**

We tested whether categorizing of ambivalent trials into situationally resolvable and situationally unresolvable ambivalent trials according to experienced ambivalence scores resulted in the desired difference between the three trial types (univalent, situationally resolvable ambivalence, situationally unresolvable ambivalence). A repeated measures Anova revealed the expected main effect of trial type on subjectively experienced ambivalence, \(F(2, 23.67) = 62.74, p < .001, \eta^2 = .77\) (Greenhouse-Geisser corrected). Whereas experienced ambivalence for univalent \((M = 7.96, SE = 2.5)\) and situationally resolvable ambivalent trials \((M = 11.66, SE = 2.79)\) did not differ \((p = .10)\), experienced ambivalence for situationally unresolvable ambivalent trials \((M = 41.80, SE = 4.14)\) was significantly higher than univalent and situationally resolvable ambivalent trials (both \(p < .001\); see Figure 4.3). This confirmed that categorization of ambivalent trials according to experienced ambivalence was successful in creating three different groups of trials.

**Behavioral results during scanning.**

A paired t-test comparing response times for ambivalent and univalent trials showed that RTs were slower for choices about ambivalent \((M = 4.03s, SE = 0.29s)\) than choices about univalent target persons \((M = 2.73s, SE = 0.13s)\), \(t(19) = 7.273, p < .001, r = .86\). Additionally, we conducted a repeated measures

\(^{14}\) Ambivalence = \((\text{Pos} + \text{Neg})/2 - |\text{Pos} - \text{Neg}|\)
Anova comparing response times based on trial type (univalent, situationally resolvable ambivalent, situationally unresolvable ambivalent), $F(2,27.51) = 43.69, p < .001, \eta^2 = .70$ (Greenhouse-Geisser corrected). As expected, response times increased from univalent trials ($M = 2.73s, SE = 0.13s$) to situationally resolvable ambivalent trials ($M = 3.85, SE = 0.28s; p < .001$) to situationally unresolvable ambivalent trials ($M = 4.19s, SE = 0.30s; p = .005$).

Assessing the distribution of response categories to the different targets showed that, as expected, participants’ responses to questions about ambivalent targets were mixed, with responses being negative (‘no’) in 53.7% of the trials and positive (‘yes’) in 46.3%. Questions about exclusively positive targets yielded mostly positive responses (85.7%) and questions about negative target individuals were mostly evaluated negatively (87.4%).

![Figure 4.3](image.png)

**Figure 4.3**
Experienced ambivalence toward univalent and ambivalent target persons in evaluative contexts (posttest). Ambivalent trials are separated by situational resolvability.

**Neuroimaging Results**

**GLM using ambivalence as categorical predictor: situationally resolvable and unresolvable ambivalence.**

Three whole-brain contrasts were calculated. To identify differences in brain activation pattern between processing of situationally resolvable inconsistent information and processing of univalent information, we first contrasted ambivalent trials eliciting low levels of experienced ambivalence with univalent trials (situationally resolvable ambivalence > univalence). This revealed four clusters more activated for situationally resolvable ambivalence:
ACC/ paracingulate extending to the superior frontal gyrus (MNI: -4, 20, 44), ventromedial frontal cortex (MNI: 10, 40, -12), left lateral frontal pole (MNI: -30, 66, 2) and the cerebellum (MNI: 52, -72, -34; Table 4.1).

Table 4.1 Peak regions of activation for the evaluation of ambivalent targets that elicit low levels of experienced ambivalence (situationally resolvable ambivalence) > univalent targets.

<table>
<thead>
<tr>
<th>Region</th>
<th>Side</th>
<th>Voxels</th>
<th>Z</th>
<th>MNI coordinates</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebellum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>y</td>
<td>z</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>2880</td>
<td>3.92e-10</td>
<td>4.47</td>
<td>52</td>
<td>-72</td>
<td>-34</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.13</td>
<td>38</td>
<td>-68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.68</td>
<td>42</td>
<td>-80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.65</td>
<td>36</td>
<td>-78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.63</td>
<td>36</td>
<td>-82</td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.6</td>
<td>-42</td>
<td>-76</td>
</tr>
<tr>
<td>ACC/ paracingulate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>y</td>
<td>z</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>964</td>
<td>0.000306</td>
<td>3.92</td>
<td>-4</td>
<td>20</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.76</td>
<td>-6</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.73</td>
<td>-4</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.71</td>
<td>-8</td>
<td>30</td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.48</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.39</td>
<td>-24</td>
<td>18</td>
</tr>
<tr>
<td>Ventromedial frontal cortex</td>
<td></td>
<td>849</td>
<td>0.000853</td>
<td>3.54</td>
<td>10</td>
<td>40</td>
<td>-12</td>
</tr>
<tr>
<td>Frontal pole</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.52</td>
<td>-22</td>
<td>64</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.4</td>
<td>-20</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.4</td>
<td>-22</td>
<td>60</td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.27</td>
<td>10</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.18</td>
<td>-14</td>
<td>62</td>
</tr>
<tr>
<td>Frontal pole (lateral frontal cortex)</td>
<td></td>
<td>462</td>
<td>0.0401</td>
<td>3.23</td>
<td>-30</td>
<td>66</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.17</td>
<td>-46</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.03</td>
<td>-36</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>-40</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.94</td>
<td>-40</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.77</td>
<td>-38</td>
<td>62</td>
</tr>
</tbody>
</table>

Clusters were determined by Z>2.3 and a corrected cluster significance threshold of p =.05 was used. Coordinates of the maximally activated voxel and the maximum Z-value are given for each cluster.

Second, we contrasted trials eliciting high levels of experienced ambivalence with univalent trials (situationally unresolvable ambivalence > univalence). Greater BOLD response was observed in the ACC/ paracingulate extending to the superior frontal gyrus and frontal pole (MNI: 0, 24, 40), a relatively
large posterior region encompassing the PCC, precuneus and parts of the thalamus and caudate (MNI: 0, -12, 10), an additional region in the superior lateral occipital cortex connecting to the TPJ (MNI: -48, -68, 40) and the orbitofrontal cortex connecting to the insula (MNI: 46, 24, -14; Table 4.2).

Table 4.2 Peak regions of activation for the evaluation of ambivalent targets eliciting high levels of experienced ambivalence (situationally unresolvable ambivalence) > univalent targets.

<table>
<thead>
<tr>
<th>Region</th>
<th>Side</th>
<th>Voxels</th>
<th>P</th>
<th>Z</th>
<th>MNI coordinates x</th>
<th>y</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC/paracingulate</td>
<td></td>
<td>12087</td>
<td>6.42e-30</td>
<td>4.84</td>
<td>0 24 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.83</td>
<td>-4 32 32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.67</td>
<td>-22 40 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frontal pole</td>
<td></td>
<td></td>
<td></td>
<td>4.42</td>
<td>4 62 16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.38</td>
<td>-8 30 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.35</td>
<td>-6 22 44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cerebellum</td>
<td>R</td>
<td>4811</td>
<td>1.33e-15</td>
<td>4.89</td>
<td>38 -68 -42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
<td>4.78</td>
<td>50 -70 -36</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.61</td>
<td>48 -72 -40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.53</td>
<td>46 -68 -44</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>4.51</td>
<td>-38 -68 -44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>4.51</td>
<td>-46 -76 -42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thalamus</td>
<td></td>
<td>2994</td>
<td>5.01e-11</td>
<td>4.29</td>
<td>0 -12 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.17</td>
<td>-10 8 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCC</td>
<td></td>
<td></td>
<td></td>
<td>4.1</td>
<td>-2 -50 22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precuneus</td>
<td></td>
<td></td>
<td></td>
<td>3.98</td>
<td>-6 -56 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.71</td>
<td>0 -34 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.64</td>
<td>-10 -54 26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPJ/ Superior lateral occipital cortex</td>
<td>L</td>
<td>1078</td>
<td>5.99e-05</td>
<td>4.04</td>
<td>-48 -68 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.72</td>
<td>-46 -64 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.72</td>
<td>-52 -66 32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.51</td>
<td>-38 -58 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.23</td>
<td>-44 -62 52</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.06</td>
<td>-38 -72 36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orbital frontal cortex</td>
<td>R</td>
<td>637</td>
<td>0.00416</td>
<td>4.26</td>
<td>46 24 -14</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.84</td>
<td>40 28 -12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.72</td>
<td>42 24 -22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.21</td>
<td>38 34 -24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.15</td>
<td>32 24 -10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.06</td>
<td>36 20 -4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insula</td>
<td></td>
<td></td>
<td></td>
<td>3.06</td>
<td>36 20 -4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Clusters were determined by $Z > 2.3$ and a corrected cluster significance threshold of $p = .05$ was used. Coordinates of the maximally activated voxel and the maximum Z-value are given for each cluster.

To further examine the effects of situational resolution of conflict, the third contrast focused on ambivalent targets, comparing activation for ambivalent trials in which inconsistency between evaluative tendencies could not be situationally resolved with trials in which evaluative context allowed situational resolution of inconsistency (situationally unresolvable ambivalence $> \text{situationally resolvable ambivalence}$). Trials in which context did not provide the possibility to resolve inconsistency was associated with greater activity in the ACC spreading to the paracingulate and superior frontal gyrus (MNI: -8, 32,30) compared to situationally resolvable ambivalent trials (Table 4.3; Figure 4.4). No regions were found more activated for situationally resolvable ambivalent trials (low experienced ambivalence) compared to situationally unresolvable ambivalent trials (high experienced ambivalence).

\textbf{Table 4.3} Peak regions of activation for situationally unresolvable ambivalence $> \text{situationally resolvable ambivalence}$.

<table>
<thead>
<tr>
<th>Region</th>
<th>Side</th>
<th>Voxels</th>
<th>$p$</th>
<th>$Z$</th>
<th>MNI coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$x$ $y$ $z$</td>
</tr>
<tr>
<td>ACC/ paracingulate</td>
<td>L</td>
<td>542</td>
<td>0.00829</td>
<td>3.17</td>
<td>-8 32 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.1 -10 22 58</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>3.03</td>
<td>2</td>
<td>30 38</td>
<td>3 2 26 38</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>2.97</td>
<td>6</td>
<td>28 28</td>
<td>2.97 6 28 28</td>
</tr>
</tbody>
</table>

Clusters were determined by $Z > 2.3$ and a corrected cluster significance threshold of $p = .05$ was used. Coordinates of the maximally activated voxel and the maximum Z-value are given for each cluster.

\textbf{Subthreshold Activations.}

As noted by Lieberman and Cunningham (2009), standard fMRI analyses are heavily biased toward reducing Type I errors at the expense of increasing Type II errors. They propose that in addition to reporting corrected results, it is important to report results at lower thresholds (e.g., uncorrected $p < .005$) to provide a more complete picture of the results. When doing this, several key,
and predicted regions emerge. Specifically, greater PCC/precuneus activation is observed for situationally resolvable ambivalence > univalence (MNI: 2, -50, 22, $Z = 2.59$). A similar region was also more activated in the situationally unresolvable ambivalence > situationally resolvable ambivalence contrast (MNI: -4, -52, 22, $Z = 1.87$). Additionally, we found greater activation in the left lateral frontal pole (MNI: -46, 44, -14, $Z = 2.33$) for trials categorized as situationally unresolvable compared to situationally resolvable ambivalent trials. This suggests that as for ACC activation, PCC/precuneus and lPFC also become increasingly engaged from univalent to situationally resolvable to situationally unresolvable ambivalent trials. However, it is important to note that because these regions did not survive the more strict procedures, these results will need to be replicated in future research.

![Figure 4.4](image)

**Figure 4.4**
Group-averaged brain activation during evaluation of ambivalent or univalent stimuli.
**Blue:** Situationally unresolvable ambivalent stimuli > Univalent stimuli; **Red:** Situationally resolvable ambivalent stimuli > Univalent stimuli. **Yellow:** Situationally unresolvable ambivalent stimuli > Situationally resolvable ambivalent stimuli.
*The left side of the brain is displayed on the right and right side of the brain is displayed on the left side.*

**Discussion**

The present study demonstrates that brain regions are indeed differentially activated according to the level of situational resolution of ambivalence indicated by self-reported experienced ambivalence. Results on behavioral (RTs), self-report, and neural level support the idea that current evaluative context and task goals can allow for unambiguous evaluative responses despite ambivalent information about the target stimulus. First, response times increased for choices on univalent trials to situationally resolvable to situationally unresolvable ambivalent trials, suggesting increasing processing
efforts from univalent to more complex, ambivalent information (univalence < situationally resolvable ambivalence < situationally unresolvable ambivalence). Second, and in line with results of Chapter 3, insula activation was only stronger for ambivalent compared to univalent trials when evaluative context did not help resolve the inconsistency between evaluations (univalence = situationally resolvable ambivalence < situationally unresolvable ambivalence). Third, we observed increased engagement of a network consisting of ACC, PFC, PCC/precuneus, involved in shaping evaluative responses, from univalent to situationally resolvable to situationally unresolvable ambivalence (univalence < situationally resolvable ambivalence < situationally unresolvable ambivalence). Our data thus support the idea that processing univalent information can be distinguished from processing of ambivalent information even if conflict can be resolved in the current situation. Results suggest that evaluative information is dynamically processed, with processing becoming increasingly complex if current evaluations have not reached a motivationally sufficient response. Implications will be discussed along these findings.

Figure 4.5
Whole-brain contrast ambivalence > univalence, left: chapter 2; right: chapter 4

We replicated the involvement of a network including ACC, PFC, PCC/precuneus as well as insula in ambivalent decision-making (Chapter 2; Cunningham et al., 2004; Figure 4.5). The greater engagement of this network for processing of more complex, ambivalent information is mirrored by longer response times for decisions on ambivalent compared to univalent trials. Producing an unambiguous response seems to require increasingly more effort, and possibly more iterations the more evaluatively complex information becomes (Cunningham & Zelazo, 2007).

Important to note is that even evaluating ambivalent information under conditions when evaluative context allowed the resolution of inconsistency
between evaluative tendencies engaged a similar, though less strong, pattern of activation that was distinct from activation as a response to evaluating univalent targets. Evaluating ambivalent information in a context that helps resolve conflict, and thereby either prevents or diminishes a subjective experience of ambivalence, generated greater prefrontal activation including ACC, ventromedial and left rostrolateral PFC. While earlier research has distinguished univalence from situationally unresolvable ambivalence that is associated with high levels of experienced conflict (e.g., Chapter 2), here we observe that processing of ambivalent information when conflict is resolvable can also be differentiated from the processing of univalent information. The finding that evaluating ambivalent information seems to demand more cognitive effort than evaluating univalent information even if context eventually helps to resolve ambivalence, suggests that making a choice based on ambivalent information is more complex regardless of contextual information. It may be that, at least in this experimental design, ambivalence about a stimulus is first detected before context influences further processing of evaluative information (Cunningham et al., 2007). That is, if evaluative context would be taken into account before detecting ambivalent information, processing of situationally resolvable ambivalent information should be similar to processing of univalent information since only one aspect of the attitude representation would be relevant for the evaluation. However, our data indicate more effortful processing of situationally resolvable ambivalent than univalent information. This interpretation is supported by longer response time for choices about situationally resolvable ambivalent targets compared to those about univalent targets.

In general, we found a greater increase in ACC, PFC, and PCC/precuneus from univalent to situationally resolvable to situationally unresolvable ambivalent stimuli. Whereas these results were robust for the situationally resolvable ambivalent > univalent contrast, only activation in the ACC survived corrections in the situationally unresolvable ambivalent > situationally resolvable ambivalent contrast. The increasing engagement of lateral PFC and PCC in evaluative processing with increasing conflict experience should thus be replicated. Activation in the ACC as a response to situationally resolvable ambivalent stimuli, in addition to even greater ACC activation for situationally unresolvable ambivalent stimuli, supports the idea of an evaluative system that initially detects evaluative conflict due to competing evaluative tendencies and subsequently engages lateral prefrontal
Ambivalence resolution in context: fMRI

areas in order to initiate reprocessing of competing information. Lateral PFC may be more engaged for ambivalent trials to reprocess conflicting evaluative information in an attempt to foreground (emphasize) and background (suppress) certain aspects in order to generate an unambiguous response in line with evaluative context. In this task, it appears that this process may be engaged whenever ambivalence is present. If processing of information in line with evaluative context cannot alleviate conflict, ACC and PCC continue to respond, possibly to indicate remaining conflict and a need for behavior change (see Figure 4.6). Activation in the ACC and PCC may thus reflect the detection and continuous monitoring of conflicting responses, signaling a need for behavior change (Botvinick et al., 2004; Carter et al., 1998; Leech & Sharp, 2014).

Figure 4.6
Increasing activation in the dorsal ACC (ambivalent > univalent) based on stimulus type during the dichotomous choice task.

Additionally, there was some indication of greater insula activation for situationally unresolvable stimuli compared to univalent stimuli. Insula activation is generally observed when experiencing negative emotional states and has been linked to physiological arousal (Critchley et al., 2000; Critchley, Wiens, Rotshtein, Öhlman, & Dolan, 2004). Greater insula activation may signal more negative affect as a response to unresolvable evaluative conflict, mirroring the results of Chapter 3. There we found that processing ambivalent
information only resulted in decreased zygomaticus activation when evaluative context did not help resolve ambivalence in the choice situation.

In sum, our results suggest that evaluative context shapes neural responses to ambivalent information. It was shown that evaluating attitudinally ambivalent information engages a network of regions activated in many social cognition tasks (Mars et al., 2012). Ambivalent information for which conflict could be situationally resolved engaged the anterior cingulate, ventromedial frontal cortex as well as left rostrolateral PFC to a greater extent than processing information that was only positive or negative. Based on the IR Model (Cunningham & Zelazo, 2007) and our data we suggest that evaluative information is processed in a dynamic fashion in order to reach an appropriate evaluative response, with ACC, PCC and prefrontal regions playing a central role in the detection of evaluative conflict and its resolution (Figure 4.1). If foregrounding and backgrounding, mediated by medial and lateral PFC, successfully solves competing evaluative tendencies, an unambiguous evaluation is formed. If this is not the case, ACC continues to be engaged and signals the necessity for executive control. Insula may then be more engaged reflecting a more negative emotional state due to evaluative conflict. Based on the low temporal resolution of MRI data, however, we can only speculate about the temporal order in which regions are engaged. Methods that allow for temporal tracing of evaluative processes are needed in future studies to shed more light on the temporal development of evaluative responses and the interplay between medial and lateral prefrontal structures in resolving ambivalence.
Chapter 5

A waste of time? The prevalence and effectiveness of choice delay in ambivalent decision-making

This chapter is based on:


We would like to thank Dylan Molenaar for his statistical advice regarding analyses in Study 3.
Feeling torn between positive and negative sides of an issue is a common, yet often unpleasant experience. It is especially unpleasant if we have to make a discrete choice about the issue we are conflicted about (Chapter 3 of this dissertation; van Harreveld, Rutjens, Rotteveel, Nordgren, & van der Pligt, 2009). Imagine having to make a decision whether or not to buy a house. On the one hand it is likely to be cheaper than renting, on the other hand buying a house can be a burden and reduce your mobility. One way of coping with this dilemma may be to delay the choice, either in an attempt to avoid having to deal with it right away or in order to create more time to think about advantages and disadvantages of your choice options. In this chapter, we will examine choice delay and its potential effectiveness as a coping strategy in ambivalent decision-making.

Ambivalence represents the existence of both positive and negative associations with an attitude object (Kaplan, 1972; Thompson, Zanna, & Griffin, 1995). It is an inconsistency that challenges humans’ motivation to be consistent in thoughts, feelings, and behaviors (Briñol & Petty, 2005). The subjective experience of ambivalence has therefore been associated with feelings of unease and tension (Hass, Katz, Rizzo, Bailey, & Moore, 1992; Heider, 1946; Festinger, 1957; Nordgren, van Harreveld, & van der Pligt, 2006). It has been found, for example, that making a personally relevant choice between the two sides of one’s attitude is associated with physiological arousal and self-reported uncertainty (van Harreveld, Rutjens, et al., 2009). Additionally, the facial EMG study reported in Chapter 3 showed that having to make a choice about a person described by ambivalent (positive and negative) characteristics results in decreased activation of the zygomaticus major muscle, a facial muscle responsible for smiling and associated with positive affect (chapter 3 of this dissertation). In light of the negative, and decreased positive affect that ambivalence can elicit in choice situations, researchers have suggested and explored several ways of coping with ambivalence, the majority of which have been integrated into the Model of Ambivalence-Induced Discomfort (MAID, van Harreveld, van der Pligt, & de Liver, 2009). Research efforts on coping with ambivalence have mostly focused on strategies aimed at ambivalence reduction. It has been shown, for example, that ambivalent attitudes are associated with more extensive processing of information and searching for new information that can help reduce ambivalence (e.g., Clark, Wegener, & Fabrigar, 2008; Hodson, Maio, & Esses, 2001; Maio, Bell, & Esses, 1996; Nordgren et al., 2006; Sawicki et al.,
According to the MAID, however, the first coping strategy ambivalent decision-makers turn to is the delay of the choice (van Harreveld, van der Pligt, et al., 2009). Choice delay requires a minimum amount of effort compared to other strategies aimed at ambivalence reduction and may be desirable for decision-makers in that it temporarily reduces the intensity of negative affect associated with the choice (see also Lazarus and Folkman, 1984; Luce, Bettman, and Payne, 1997). Surprisingly though, choice delay has thus far been neglected in research on ambivalent decision-making and its prevalence has neither been confirmed nor disconfirmed. The first question to be addressed here is thus whether choices about topics individuals are ambivalent about are in fact more often delayed than choices about univalent topics.

If this is indeed the case, the questions arise as to why individuals delay choices and whether there is any benefit in delaying an ambivalent choice. That is to say, contrary to the potential short-term benefits of choice delay suggested above, others have emphasized predominantly negative long-term consequences of delaying unavoidable tasks, such as increased stress levels, adverse health consequences over time as well as worse academic performance (Tice & Baumeister, 1997). Some have even gone as far as stating that procrastination is “usually harmful, sometimes harmless, but never helpful” (Steel, 2007, p. 80).

Long-term consequences, and thus the effectiveness of choice delay as a coping strategy in ambivalent decision-making are possibly moderated by the way in which the time generated by choice delay is spent. Oftentimes individuals delay tasks with the intention to pursue other, distracting activities (Dewitte & Schouwenburg, 2007). Klingsieck (2013), however, suggests that delaying a task can be functional and possibly have positive long-term consequences, if the time is used in a purposeful way. Such strategic delay of a decision may create the time that allows individuals to carefully weigh costs and benefits of the choice options (cf. Knaus, 2000). This could foster the decision-making process, and provide a more permanent solution to reduce attitudinal conflict and stress. Yet deliberating about an ambivalent issue may also increase ambivalence if decision-makers concentrate on the conflicted components of their attitude without being able to solve their ambivalence. This may especially be the case when individuals are not given any new information that helps to reduce their ambivalence. Two more
questions thus call to be answered in this paper. If individuals tend to delay a choice about an ambivalent topic, we need to identify whether they prefer to deliberate about, or favor distraction from the topic. Second, we seek to determine whether deliberation about or distraction from a delayed choice topic is beneficial in ambivalent decision-making. It is possible that even though time is used in a more purposeful way in strategic delay, the experience of attitudinal conflict does not decrease but rather increases due to deliberation.

The aim of this chapter is thus to explore choice delay in ambivalent decision-making. Several questions that have yet remained unanswered in the literature on coping with ambivalent decision-making will be addressed here. First, we will test in a real-world setting whether and under which circumstances choice delay occurs in ambivalent decision-making (Studies 5.1a and 5.1b). These studies are conducted outside of the lab to be able to draw conclusions about the prevalence of choice delay in everyday situations in which individuals are unaware that their behavior is under scrutiny. In a second study, we investigate how people prefer to use the time created by the delay, i.e. do they avoid the decision problem or do they try to resolve their ambivalence even if they are not given any new information (strategic delay; Study 5.2). In a third study, we will examine the effects of choice delay in combination with deliberation and distraction on the experience of ambivalence and negative affect over time. The present research thus aims to get an indication of the prevalence of choice delay in ambivalent decision-making and whether it helps to reduce evaluative conflict and negative affect dependent on whether the created time is spent on distraction from or deliberation about the ambivalent issue.

**Study 5.1A**

In the first two studies (Study 5.1a and Study 5.1b), we examined whether dichotomous choices about ambivalent topics are delayed more often than choices about univalent topics. Ambivalence was manipulated on the basis of pretested scenarios. Both studies were conducted outside of the laboratory.

Ambivalent attitudes are generally attitudes of high involvement because of their strong positive and negative associations with the attitude object that distinguish ambivalence from indifference (Kaplan, 1972). Involvement can be based on personal consequences, values, or social norms (Boninger, Krosnick,
& Berent, 1995). However, creating strong attitudes that individuals feel involved with is challenging in an experimental setting and most research on ambivalence therefore relies on already existing attitudes (e.g., Maio, Bell, & Esses, 1996; Pillaud, Cavazza, & Butera, 2013). To account for the importance of involvement, we assessed individuals’ involvement with the attitude object and choice. Note that in earlier studies in this dissertation we have used forced dichotomous choices in order to increase involvement (Chapters 2-4). However, contrary to the current study in which we use a one-choice paradigm, in earlier studies participants had to make several choices to get a reliable physiological assessment of our dependent variable. Because we used self-report in this study and only one choice, we chose to assess participants’ involvement with the choice to get an indication of how relevant the stimulus was for them.

Method: Study 5.1A

**Participants and Design.** Sixty participants (30 male, mean age = 37.02, $SD = 17.41$) were recruited before entering a supermarket and randomly assigned to the ambivalent or univalent information condition.

**Procedure.** Participants were approached by an experimenter at the entrance to a supermarket and verbally given either univalent or ambivalent, pretested information about a proposal for free wireless internet in several parks in Amsterdam. Participants were only given favorable information about the proposal in the univalent version (e.g., good service, free), whereas they were given evaluatively mixed information in the ambivalent version (e.g., reduced green area, installation process will partly close off the parks). Participants were told that the municipality intended to take the public opinion into account when making a decision and were asked whether they supported the proposal or were against it. Directly after the manipulation of either ambivalence or univalence, participants were given the possibility to delay their decision about the proposal until after they finished shopping when they would again be approached by the experimenter. If participants opted for delaying their choice, the experimenter indeed approached participants again.

---

15 Involvement can be seen as a prerequisite for ambivalence and distinguishes it from indifference. Making the correct decision is even more important for highly involved individuals, thus experiencing conflict between the options should lead them to delay the choice more often. However, if the attitude topic is clear and univalent, no conflict between options is experienced and involvement should have no effect on choice delay.
when exiting the supermarket in order to guarantee a response. Experimenters noted whether participants were for or against the proposal and whether they had postponed their decision. As an indication of how involved the individual was with the decision, we asked participants to specify how much they generally use these parks ranging from *only rarely* (1) to *very much* (10) after they had made their choice. Park use was chosen as an indication of involvement with the decision because the decision for or against WIFI in the parks is more consequential for individuals who frequently visit at least one of the parks. We expected the effects of ambivalence to be most pronounced for individuals with higher levels of involvement.

**Results and Discussion: Study 5.1A**

Of all participants, 78.3% favored the Wi-Fi proposal and 21.7% were against it. One participant failed to give an indication of how much she used the parks and was excluded from the analysis using involvement as a predictor of decision delay.

<table>
<thead>
<tr>
<th></th>
<th>B (SE)</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-3.064** (0.969)</td>
<td>0.63</td>
<td>49.93</td>
</tr>
<tr>
<td>Ambivalence</td>
<td>1.721 (1.117)</td>
<td>0.92</td>
<td>45.06</td>
</tr>
<tr>
<td>Park visits</td>
<td>-0.920 (0.736)</td>
<td>0.09</td>
<td>1.69</td>
</tr>
<tr>
<td>Park visits X ambivalence</td>
<td>1.956* (0.945)</td>
<td>1.11</td>
<td>45.06</td>
</tr>
</tbody>
</table>

Note $R^2 = .166$ (Cox & Snell), .278 (Nagelkerke). Model $\chi^2(3) = 10.70, p = .013$. *$p = .038$, **$p = .002$.

To assess whether decisions about ambivalent topics are more often delayed than univalent decisions, a chi-square test was conducted and revealed a significant association between type of information (ambivalent vs. univalent) and choice moment (immediate vs. delayed), $\chi^2 (1) = 5.46, p = .02$. According to the odds ratio, ambivalent participants were 6.00 times more likely to delay the choice than univalent participants. A logistic regression analysis on choice delay including ambivalence (vs. univalence) as a categorical and frequency of park visits as a continuous predictor supported the full model (Table 5.1), it
correctly classified 79.7% of the cases. According to the Wald criterion only
the interaction between ambivalence and frequency of park visits served as a
significant predictor ($p = .038$). As expected, the probability of postponing the
choice for ambivalent participants increased by the frequency that these
participants indicated to use the parks (Figure 5.1).

![Figure 5.1](image)

**Figure 5.1**
Probability of choice delay dependent on ambivalent vs. univalent
information and participants’ self-reported frequency of park usage
(standardized scores).

This study provides a first indication that individuals are more likely to delay
a decision about a topic they are ambivalent about compared to a decision
about a univalent topic; this was especially the case when individuals were
more involved with the topic they were making a choice about.

**Study 5.1B**

**Method: Study 5.1B**

**Participants and Design.** In a second study 60 participants (33 male) with a
mean age of 47.22 years ($SD = 19.81$) were recruited before entering a
supermarket. Participants were again randomly assigned to the ambivalent or
univalent information condition.

**Procedure.** The experimental procedure was comparable to the previous
study, except that the presented information concerned a fictitious food-bank
organized by students in Amsterdam. In the univalent scenarios participants were only given favorable information about the project (e.g., 90% of donations go to the program, importance of food banks for low income families), whereas participants were given evaluatively mixed information in the ambivalent scenarios (e.g., 70% of the donations go to the program, difficult balance between supporting low income families and keeping them self-determined). After receiving the information, participants were asked whether they would like to support the food program with a nonrecurring financial contribution of their own choosing. Personal involvement was assessed by asking participants whether they already supported other charitable organizations (yes/no). It was assumed that participants who give donations to other charitable organizations are more involved with societal issues and thus more willing to consider supporting the project. Note that contrary to study 5.1a, we used a categorical measure to assess involvement instead of a continuous one.

Results: Study 5.1B

Thirty of sixty participants decided to support the project with €1.72 on average. As in the previous study, the association between ambivalence and choice delay was tested with a chi-square distribution. Results reveal a marginally significant association between the type of information (ambivalent vs. univalent) and whether or not participants delayed their decision $\chi^2 (1) = 3.068, p = .08$.

Subsequently we conducted loglinear analysis to test whether participants were more likely to delay an ambivalent than a univalent choice if they were more involved compared to less involved (all categorical variables). Three out of eight expected frequencies per cell were under 5, thus violating one of the assumptions of loglinear analysis (Field, 2013). This results in a loss of power, nevertheless the final model was a good fit of the data with a likelihood ratio of $\chi^2(0) = 0, p = 1$. However, the highest-order interaction (ambivalence * choice delay * involvement) was not significant, $\chi^2(1) = 2.52, p = .11$. Because of the hypothesis that involvement is an important moderator in the effect of ambivalence on choice delay and the fact that the test is overly conservative due to the violation of one of the assumptions, we followed up with chi-

---

16 Participants did not actually give the experimenter any money, but indicated the amount of their contribution next to their choice.
square tests within groups of lowly and highly involved participants. We found the effect of ambivalence on choice delay to be stronger for participants who already supported other charitable organizations, $\chi^2(1) = 6.036, p = .01$, than for participants who did not support any charitable organizations, $\chi^2(1) = 0.08, p = ns$. Participants who supported other organizations ($N = 37$) were 6.38 times more likely to postpone an ambivalent decision than a univalent decision. Based on the fact that only a relatively small number of participants (7 of 23; 30.4%) who did not support any other charity decided to support the food bank program in this study compared to 62.2% (23 of 37) of the participants supporting other charities, it can be assumed that independent of information condition, the decision to support the program was less relevant and possibly less ambivalent for these participants (cf. Footnote 15). Therefore they probably showed only little influence of our ambivalence manipulation on choice delay.

**Discussion: Study 5.1**

Delaying tasks is a well-known phenomenon with estimated prevalence rates of up to 95% in the student population (Ellis & Knaus, 1977; cited in Steel, 2007). In general, decisions and tasks are delayed when they are aversive, difficult, or when individuals are uncertain about the consequences of their decisions (e.g., Anderson, 2003; Hogarth, Michaud, & Mery, 1980; Milgram, Sroloff, & Rosenbaum, 1988; Solomon & Rothblum, 1984; Tversky & Shafir, 1992). Ambivalent decisions share several of these features, and Study 5.1 a) and Study 5.1 b) confirm that choice delay is also prevalent in ambivalent decision-making. Individuals who are confronted with ambivalent information in an everyday situation spontaneously delayed dichotomous choices regarding the ambivalent topic more often than univalent decision-makers. Personal involvement seemed an important factor in the sense that ambivalent participants who were more involved with the issue were most inclined to delay the choice. We suggest that this effect is driven by the degree to which the presented information led participants to experience ambivalence. Participants who are not involved in the issue may be more likely to be indifferent and less likely to feel ambivalent when receiving conflicting information.

**Study 5.2**
The second study built upon the results of the previous field studies. Knowing that individuals who are ambivalent about a choice topic are more likely to delay the choice moment than individuals who are not ambivalent, raises the question why people prefer to delay an ambivalent choice. Two opposing hypotheses can be formulated based on the literature. On the one hand, individuals may want to avoid thinking about the topic and simply look for distraction (cf. Ferrari, Johnson, & McCown, 1995). This is in line with a counterproductive interpretation of task delay, and the suggestion that aversive tasks are often delayed in order to spend time on other, distracting activities (Dewitte & Schouwenburg, 2007; Steel, 2007). On the other hand, the created time could also be used to elaborate on the ambivalent topic, possibly in an attempt to create a less conflicted evaluation, mirroring a more functional approach to delay (i.e. Klingsieck, 2013). To get a tentative impression of which of these two approaches is most likely, we measured participants’ preferences for the type of delay and assessed whether this preference was influenced by (negative) affect and the experience of ambivalence.

Both previous studies suggest that participants have to be involved with the attitudinal issue in order to delay the choice due to their ambivalence. Consequently, we used an already existing ambivalent attitude by asking participants to think of a topic that elicits strong positive and negative reactions in them (van Harreveld, Rutjens, Schneider, Nohlen, & Keskinis, 2014; Schneider et al., 2013).17

**Method: Study 5.2**

**Participants and Design.** 109 undergraduates of the University of Amsterdam participated in the study in return for €7 or course credit. Four participants were excluded from the dataset prior to analyses, two because they wrote down more than one ambivalent topic, one due to computer problems, and one because she mentioned to have participated in one of our earlier studies and indicated that she had adjusted her responses accordingly. A total of 105 participants remained in the dataset (77 female, $M_{age} = 21.49$, $SD_{age} = 3.19$).

17 We also manipulated regulatory focus in this study to explore whether the time management during choice delay may be associated with a particular mindset (i.e. promotion or prevention; Higgins, 1997). However, the manipulation of regulatory focus failed as indicated by a manipulation check ($F < 1$, $p = .ns$); this variable was dropped from further analyses and not reported further for reasons of clarity.
Procedure. Ambivalence was induced by asking participants to think of and write down a topic they believe has positive and negative sides (van Harreveld et al., 2014; Schneider et al., 2013). Participants reported topics such as abortion, organ donation, or buying a house. To see whether participants were ambivalent about the topic they had chosen, we measured their subjective experience of ambivalence using the subjective ambivalence scale (Priester & Petty, 1996). This scale consists of three items measuring the ‘indecision’ about, ‘mixed reactions’ and ‘conflict’ toward the attitude object. Responses were given on scales ranging from feel no indecision, completely one-sided reactions, and feel no conflict (0) to feel maximum indecision, mixed reactions and feel maximum conflict (100; Time 1 = .72, Time 2 = .84).

After participants indicated to what degree they experienced several emotions (regret, arousal, tension, and nervousness) on a scale ranging from not at all (0) to very much (100; Time 1 = .85, Time 2 = .86, Time 3 = .87), participants were told that they would have to make a clear dichotomous choice about the ambivalent topic they had generated. We then measured our main dependent variable, namely how they wanted to spend the time until they had to make the decision. They could choose between a) deliberating by writing down the pros and cons of the issue or b) doing an unrelated task in which they would describe the route from their house to the university. Both tasks took the same amount of time, which was set between three and five minutes. A timer indicated to participants how long they had spent on the task. After this task, participants again filled in the four-item emotion scale (regret, arousal, tension, and nervousness) and made a choice. We then measured subjective ambivalence, and asked them to fill in the emotion scale for the third time.

Results: Study 5.2

Participants’ subjective ambivalence was comparable to ambivalence levels reported in other studies using a similar ambivalence induction indicating that participants indeed thought of a topic they felt ambivalent about (Schneider et al., 2013; Time 1 = 59.48, SD time1 = 18.93; Time 2 = 48.80, SD time2 =

---

18 We initially measured 20 affect items (happiness, joy, satisfaction, enthusiasm, anger, irritation, nervousness, panic, fear, regret, despair, disappointment, guilt, shame, sadness, tension, relaxed, surprise, arousal, stress). To be in line with our other studies that assessed self-reported negative affect, we concentrated our analyses on four negative affect items that were assessed at all measurement moments in this study and the other studies described here. These finally assessed affect items are also similar to the subset of items used in van Harreveld, Rutjens et al. (2009). Using all negative affect items measured yielded similar results.
22.09). Additionally, participants reported relatively low levels of negative affect across time ($M_{time1} = 12.59, SD_{time1} = 14.73; M_{time2} = 10.63, SD_{time2} = 14.01; M_{time3} = 9.48, SD_{time3} = 12.83$).

When given the time to delay the choice, 62.9% of participants chose to distract themselves from their ambivalent attitude by writing down their route to the university, whereas 37.1% decided to deliberate about the ambivalent topic, $\chi^2 (1) = 6.94, p = .008$, indicating that participants in general preferred to distract themselves from the upcoming choice rather than use deliberation to resolve their conflict. Interestingly, participants preferred the distraction task over deliberation even though the distraction task was not designed to be inherently pleasant, and in fact was rather tedious. Surprisingly though, the choice for deliberation or distraction was not predicted by level of subjective ambivalence or negative affect assessed after the ambivalence induction, as revealed by a logistic regression analysis using negative affect and level of subjective ambivalence as predictors of choice for deliberation or distraction, $\chi^2 (2) = 1.13, p = ns$. Later measures of negative affect and subjective ambivalence were thus not analyzed.

**Discussion: Study 5.2**

Study 5.2 illustrates that ambivalent individuals do not engage in strategic delay in the time that is generated by postponing the choice when other moderators are not taken into account. When given the opportunity, significantly more people chose a distraction task over a deliberation task despite knowing of the upcoming choice. An alternative explanation may be that this is due to the design of the study in that ambivalent topics were self-generated and may thus have been resistant to previous resolution attempts (otherwise they would be univalent). This suggests that participants chose to distract themselves because they believed that it would be difficult to resolve conflict without receiving any new information about the topic. However, this argumentation implies that the more ambivalence participants experienced the more likely they should have been to distract themselves. Since we did not find any relation between experienced ambivalence and the choice for distraction, this alternative explanation seems less likely. To counteract that participants may have thought that ambivalence about the chosen topic was unresolvable, we decided to manipulate ambivalence with the same topic for all participants. After revealing that individuals prefer distraction over deliberation in ambivalent decision-making, we manipulated time use,
ambivalence, and delay in the following study in order to fully investigate the consequences of the different types of choice delay in ambivalent decision-making.

**Study 5.3**

As the previous studies established that a) decisions about ambivalent topics are more likely to be delayed than decisions about univalent topics, and that b) when given the opportunity to delay, individuals more often choose distraction over deliberation, the goal of Study 5.3 was to test the effectiveness of delay and distraction as a coping strategy in ambivalent decision-making. As the earlier studies in this chapter pointed in the direction that participants’ involvement plays an important moderating role in the effect of ambivalence on choice delay, we also introduced choice consequences in this last study to increase participants’ involvement with the choice.

The effectiveness of delay in decision-making may depend on how the time is spent (distraction vs. deliberation) and what the outcome variable is (affect vs. ambivalence). In general, having to make a choice about an ambivalent topic is thought to result in increased negative affect due to the inconsistency between evaluations that develops from an ambivalent attitude (chapter 3; van Harreveld, Rutjens, et al., 2009). According to the MAID (van Harreveld, van der Pligt et al., 2009), delay of such an ambivalent choice should consequently decrease negative affect for the time being. However, this effect may not last if ambivalence is not resolved permanently during the delay and may lead to more negative affect once a choice has been made. An increase in negative affect after the choice would be in line with accumulating evidence of the negative long-term effects of delay, suggesting that any benefit of delaying an ambivalent choice may only be short-lived (e.g., Steel, 2007; Tice & Baumeister, 1997).

However, the question remains whether either choice delay or deliberation and distraction may influence negative affect and experienced ambivalence independently from each other. Whereas oftentimes negative affect and the experience of ambivalence are paralleled in studies on ambivalence (see Chapter 1), deliberation and distraction may mainly have an influence on the experience of ambivalence as deliberation is aimed at ambivalence reduction, but not directly at decreasing negative affect. This is contrary to choice avoidance in general, which is thought to be used to diminish the negative
experience of the choice event that is being delayed instead of reducing ambivalence (Luce, Bettman, & Payne, 1997).

In general it has been suggested that ambivalence is best reduced by deliberating about the pros and cons of each choice option (Nordgren, van Harreveld, & van de Pligt, 2006; van Harreveld, van der Pligt et al., 2009). Consistently, de Liver and colleagues (2007) found that putting participants under cognitive load while they were evaluating ambivalent attitude objects resulted in higher levels of ambivalence as it hindered the process of ambivalence reduction through deliberation. This would suggest that distraction would also hinder the resolution of ambivalence and result in increased ambivalence compared to when individuals are able to deliberate about the ambivalent topic. On the other hand, deliberation may lead to greater ambivalence if participants are not able to resolve their ambivalence and continue to ruminate over their conflicted attitude. This may especially be the case when participants are not given any new information on the topic to help them resolve ambivalence.

To investigate whether delaying an ambivalent choice is functional or detrimental for the ambivalent individual dependent on how the time is spent and to investigate whether delay and deliberation may have different effects on self-reported ambivalence and negative affect, we manipulated ambivalence, choice delay, and time use (distraction vs. deliberation) in the following study.

**Method: Study 5.3**

**Participants and Design.** 199 students and alumni of the University of Amsterdam participated in the study for course credit or an equivalent monetary reward. They were randomly assigned to the eight cells of the 2 (ambivalence vs. univalence) by 2 (delay vs. immediate) by 2 (distraction vs. deliberation) between-subject design. Subjective ambivalence and negative affect were measured three times during the experiment (after the manipulation, before the choice, and after the choice, see Figure 5.2 for a graphic overview of the study).

Five participants were excluded from the analysis; three of them quit the experiment because they did not want to be videotaped and two additional participants because of technical failure. This left us with 194 participants (144 female, $M_{age} = 21.23$, $SD_{age} = 3.86$).
Procedure. Upon arrival at the lab participants were seated in individual cubicles and the experimenter started the computer program. Ambivalence was manipulated using a fake summary article on a recent political discussion over shortening the legal period for abortions in the Netherlands (cf. van Harreveld et al., 2014). In the ambivalent version of the text, participants read about advantages and disadvantages of changing the legislation on abortion, whereas they were given only favorable information in the univalent version. We then measured their subjective experience of ambivalence with three items (Priester & Petty, 1996; $\alpha_{\text{Time 1}} = .81$, $\alpha_{\text{Time 2}} = .85$, $\alpha_{\text{Time 3}} = .87$) and negative affect with four emotion items (nervousness, regret, arousal, tension) ranging...
from do not experience this emotion at all (0) to experience this emotion very strongly (100; \( \alpha_{\text{Time 1}} = .87, \alpha_{\text{Time 2}} = .91, \alpha_{\text{Time 3}} = .92 \))\(^{19}\).

Dependent on time use (distraction vs. deliberation), participants were then either asked to describe the route from their home to the university (distraction) or to list their arguments, thoughts, and feelings about changing the legal period in which abortion is allowed (deliberation). Participants in both time use conditions were given seven minutes to complete the task. Before starting their task, participants in the delayed choice condition were told that they were to make a choice about whether they were for or against changing the legal period of abortion and that we would ask them to defend their choice in front of a webcam at the end of the experiment. This was done in order to increase involvement with the choice. Participants in the immediate choice condition were unaware of having to make a choice until after completing the task and were then given the same information. This manipulation allowed us to keep the time between the ambivalence manipulation and choice moment constant for all participants while simultaneously simulating a situation of delay. After the task, participants made a dichotomous (for/against) choice about changing the legal period for abortion. Subjective ambivalence (Priester & Petty, 1996) and negative affect were measured immediately before and after the choice.

**Results: Study 5.3**

**Preliminary analyses.** Assessing subjective ambivalence right after the manipulation revealed that participants who were given ambivalent information about the legal period for abortion did not experience significantly more ambivalence (\( M = 48.34, SD = 23.64 \)) than participants who were given univalent information (\( M = 44.37, SD = 21.52 \)), \( F(1,192) = 1.49, p = .23 \), indicating that the manipulation of ambivalence was unsuccessful in this study. We therefore used the first measurement of subjective ambivalence (after the manipulation) as a continuous predictor in the analyses (\( M_{\text{time 1}} = 46.39, SD_{\text{time 1}} = 22.71 \)).

\(^{19}\) We also measured how positive and negative individuals' opinion was about abortion on two separate scales scale ranging from 0 (not positive; not negative) -100 (very positive; very negative) in order to calculate potential ambivalence: \( (\text{Pos-Neg})/2 - |(\text{Pos-Neg})| \). This measure was not included in the analyses in order to be consistent across chapters.
Negative affect. Data were positively skewed for the negative affect measures. Transforming the scores successfully relieved the problem of skewness, however it increased kurtosis scores to a maximum of 2.47. Bootstrapping and non-parametric tests were therefore used in order to run more robust analyses.

Since the unsuccessful manipulation of ambivalence forced us to use both, continuous and categorical predictors of a repeated, continuous outcome measure (negative affect), we conducted a multiple regression analysis. This meant we had to calculate difference scores of negative affect (after − before the choice) as the dependent variable in order to run the analysis.

First, we conducted a regression analysis on the change in negative affect (after - before the choice) predicted by ambivalence (continuous), time use (deliberation = 0, distraction = 1), choice delay (delay = 0, immediate = 1) and their interactions. Negative affect after the manipulation was also added as a continuous predictor in order to control for possible negative affect differences at time 1. We took 1000 bootstrap samples, and bootstrap confidence intervals were bias-corrected. Two models were tested, first the model with all main effects (level of ambivalence, time use, choice delay) and then the model including all main effects and interaction effects. Both models were found to fit the data, however, F did not change significantly between the two models, we thus report the data of the simpler model including only the main effects, $F(4,185) = 8.859, p < .001, R^2 = .16$ (Table 5.2).

Table 5.2 Regression Model for the prediction of change in negative affect (after − before choice) by negative affect at time 1 (zero-centered), ambivalence (zero-centered), deliberation (reference category), and choice delay (reference category).

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>Bias-corrected 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>5.234*</td>
<td>1.66</td>
<td>1.75 − 8.43</td>
</tr>
<tr>
<td>Delay</td>
<td>-8.64*</td>
<td>1.49</td>
<td>-11.85 − -5.44</td>
</tr>
<tr>
<td>Deliberation</td>
<td>1.77</td>
<td>1.56</td>
<td>-1.52 − 4.81</td>
</tr>
<tr>
<td>Ambivalence</td>
<td>0.00</td>
<td>0.03</td>
<td>-0.07 − 0.07</td>
</tr>
<tr>
<td>Negative affect</td>
<td>0.04</td>
<td>0.05</td>
<td>-0.04 − 0.13</td>
</tr>
</tbody>
</table>

Note: $R^2 = .16$. **p ≤ .005.
Choice delay was the only significant predictor of negative affect, $B = -8.64$, $SE = 1.49$, $p = .001$, 95% CI [-11.85, -5.44]. Keeping negative affect at time 1, experienced ambivalence, and time use constant, immediate decision-makers experience less negative affect after the choice compared to before the choice, whereas the effect reverses for delayed decision-makers. For clarity purposes, Figure 3 shows the mean negative affect scores separately for time 2 (before) and time 3 (after the choice).

![Bar chart](chart.png)

**Figure 5.3**
Means (SE) of negative affect before and after the choice dependent on choice delay (Study 5.3).

Nonparametric tests were used to test whether the simple contrasts were significant. We applied Bonferroni corrections (three comparisons) so all reported effects are tested against a .0167 level of significance. First, we tested whether negative affect before the choice significantly differed from negative affect after the choice using Wilcoxon signed ranks test. To take the effect of choice delay into account, we ran the analysis separately for the immediate and delayed choice group. This analysis confirmed that for immediate decision-makers, negative affect decreased significantly after the choice ($Z = -3.25$, $p = .001$), whereas negative affect increased after the choice for participants for whom choice was postponed, $Z = -4.39$, $p < .001$. To make sure that negative affect before the choice does not differ significantly between immediate and delayed decision-makers due to the choice being unexpected for immediate decision-makers, we conducted a Mann-Whitney Test on negative affect before the choice predicted by delay condition. Negative affect
before the choice did not differ significantly between the delayed and immediate decision-makers ($U = 4052.5$, $p = .10$), indicating that immediate decision-makers did not experience more negative affect even though they had to make an unexpected choice.

**Subjective ambivalence.**

As for the analyses on negative affect, the effects of choice delay and time use on experienced ambivalence over time were also tested with a multiple regression analysis due to the unsuccessful manipulation of ambivalence. This meant we had to calculate difference scores of subjective ambivalence (after – before the choice) as the dependent variable in order to run the analysis. We regressed subjective ambivalence before and after the choice by ambivalence at time 1 (continuous predictor), time use (deliberation = 0, distraction = 1), choice delay (delay = 0, immediate = 1) as well as all interaction terms.

Table 5.3 Regression Model for the prediction of change in subjectively experienced ambivalence (after – before choice) by ambivalence (zero-centered), deliberation (reference category), choice delay (reference category) and the interaction of ambivalence and deliberation (Study 5.3).

<table>
<thead>
<tr>
<th>Step 1</th>
<th>B</th>
<th>SE</th>
<th>$β$</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.39</td>
<td>1.49</td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Delay</td>
<td>-1.05</td>
<td>1.70</td>
<td>-.05</td>
<td></td>
</tr>
<tr>
<td>Deliberation</td>
<td>-1.48</td>
<td>1.70</td>
<td>-.06</td>
<td>-4.83</td>
</tr>
<tr>
<td>Ambivalence</td>
<td>0.03</td>
<td>0.04</td>
<td>.05</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>B</th>
<th>SE</th>
<th>$β$</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.25</td>
<td>1.44</td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Delay</td>
<td>-1.16</td>
<td>1.64</td>
<td>-.05</td>
<td></td>
</tr>
<tr>
<td>Deliberation</td>
<td>-1.45</td>
<td>1.64</td>
<td>-.06</td>
<td>-4.69</td>
</tr>
<tr>
<td>Ambivalence</td>
<td>0.18</td>
<td>0.05</td>
<td>.34**</td>
<td>0.07</td>
</tr>
<tr>
<td>Ambivalence*deliberation</td>
<td>-0.28</td>
<td>0.07</td>
<td>-.39**</td>
<td>-0.42</td>
</tr>
</tbody>
</table>

Note: $R^2 = .009$ at Step 1, $∆R^2 = .07$ for Step 2 ($p < .001$). **$p ≤ .001$.**

While main effects were entered into the initial model, interaction effects were entered hierarchically. The model including all main effects and the interaction between ambivalence and time use had a significant fit with the data, $F(4,189) = 4.068$, $p = .003$, $R^2 = .08$ (Table 5.3). Ambivalence after the manipulation was a significant predictor of the difference between
experienced ambivalence for compared to after the choice, indicating that the more ambivalence individuals experienced at time 1, the more ambivalence increased after compared to before the choice, $B = 0.18$, $SE = 0.05$, $p = .001$, 95% CI [0.07, 0.28]. Additionally, we observed a significant two-way interaction of ambivalence and time use on difference scores of subjective ambivalence (see Figure 5.4), $B = -0.28$, $SE = 0.07$, $p < .001$, 95% CI [-0.42, -0.13]. Deliberation led to increasing levels of experienced ambivalence the higher participants’ initial level of ambivalence. Distraction had the opposite effect: The higher individuals’ initial ambivalence, the lower their ambivalence after compared to before the choice when they were distracted from their ambivalence. No significant main or interaction effect with choice delay was observed.

![Figure 5.4](image)

**Figure 5.4** Interaction between subjectively experienced ambivalence (zero-centered) after the manipulation and deliberation vs. distraction on the difference between subjective ambivalence before vs. after choice. Higher scores indicate greater subjective ambivalence after compared to before choice.

**Discussion: Study 5.3**

Study 5.3 illustrates the influence of immediate compared to delayed choices on attitudinal conflict and negative affect as a function of whether participants deliberated about or distracted themselves from the choice topic. Interestingly, we did not find an interaction of choice delay and deliberation (vs. distraction) on neither negative affect nor self-reported ambivalence, suggesting that delaying a choice in order to deliberate about an evaluative conflict is not more (or less) beneficial than distracting oneself from the conflict. Whereas delaying the choice influenced negative affect participants experienced around the choice moment, the subjective experience of
ambivalence was affected by whether participants deliberated about or distracted themselves from the choice topic\textsuperscript{20}.

Delayed choices led to an increase in negative affect independent of how the time was spent. Notably, this effect also occurred independently of the initial level of ambivalence, suggesting that delay may be detrimental for the decision-maker irrespective of whether the choice is about a conflicted topic or not. This pattern of results supports the suggestion that delaying a task is counterproductive in the long run as choice delay increased negative affect independent of ambivalence (cf. Steel, 2007). It is important to note that we measured general negative affect in these studies, and did not explicitly ask participants to indicate negative affect as a response to evaluative conflict (e.g., feeling irritated about not knowing which choice to make). Negative affect as a response to ambivalence may have been more accurately assessed by the subjective ambivalence scale which measures conflict experience (e.g., I feel torn between the pros and cons of my evaluation). This may have especially been the case because both measures were repeatedly assessed after each other. Surprisingly, results did not show any affective short-term benefits of choice delay. It is possible, however, that these benefits had passed by the time negative affect was measured in the experiment. A continuous, possibly physiological measure of affect (e.g., GSR, EMG) as well as measuring affect in relation to the attitude topic instead of assessing the general affective state, may be able to shed more light on the dynamics of negative affect in response to choice delay.

Contrary to negative affect, the change in subjective experience of ambivalence was not affected by whether individuals delayed the choice or not, but was influenced by individuals’ previous level of ambivalence and whether they thought about or distracted themselves from the choice topic. For individuals low in ambivalence after the manipulation, neither deliberation nor distraction made a difference to their experience of conflict. For individuals high in ambivalence, however, the results suggest that the more ambivalent individuals are to begin with, the greater the increase in experienced ambivalence after the choice when having deliberated about the

\textsuperscript{20} Despite the differential effects for the subjective experience of ambivalence and negative affect, the two measures correlated significantly with each other before as well as after the choice, respectively $r = .15$, $p = .03$ and $r = .22$, $p = .002$. The more subjectively ambivalent individuals were the more negative affect they experienced.
attitude object. As ambivalent attitudes are relatively pliable and unstable over time (Armitage & Conner, 2000), generating thoughts about the ambivalent topic temporarily reduced conflict as suggested by a lower subjective experience of ambivalence before the choice, however it led to an increase in ambivalence experience after the choice. Instead of making up their mind about the ambivalent topic, participants who thought about their ambivalence seemed to make themselves feel more ambivalent through deliberation. This may be explained by the fact that participants did not receive new information that enabled them to significantly change their attitude. Instead, they possibly ruminated about the conflicted components of their attitude without being able to resolve their ambivalence, which made the conflict more salient. Distraction from the choice topic seemed to be more beneficial for ambivalent individuals as their experience of ambivalence decreased after the choice. However, interpretation of these data is limited by the relatively small effect size and the fact that the significant change seems to be driven by the difference in ambivalence scores before the choice. Arguably, this may be due to the fact that ambivalence was measured directly before and after the choice. It is possible that the suggested effect on subjective ambivalence might lead to stronger differences when more time has elapsed after the choice. This is supported by the fact that we found a change in the experience of ambivalence despite the extremely short period of time between the two measurements.

General Discussion

Ambivalence is often experienced as negative, especially in relevant decision-making situations (Hass, Katz, Rizzo, Bailey, & Moore, 1992; van Harreveld, Rutjens, et al., 2009). Four studies were conducted in order to investigate delay as a coping strategy in ambivalent decision-making. The first two field studies uncovered that when given the opportunity, ambivalent choices are spontaneously postponed more often than univalent choices, supporting the idea that ambivalent individuals indeed turn to choice delay as a coping strategy (cf. van Harreveld, van der Pligt et al., 2009). This effect was especially pronounced for individuals who were more involved with the choice. In addition, our results reinforce the idea that ambivalent decision-makers prefer to distract themselves rather than think about and resolve their ambivalence when delaying the choice (Study 5.2). This is in line with the suggestion that individuals are generally motivated to exert as little cognitive
effort as necessary (Payne, Bettman, & Johnson, 1993) and thus choose the coping strategy that requires least cognitive effort. This may especially be the case when ambivalent individuals are not given additional information that could help them resolve attitudinal conflict. Correspondingly, Clark and colleagues (Clark, Wegener, & Fabrigar, 2008) observed that individuals process information that can help to decrease their ambivalence more extensively and try to avoid messages that are likely to increase their ambivalence. As participants in our study were not given any new information that could possibly decrease their ambivalence, they may have been motivated to avoid thinking about their attitude altogether. This reasoning is supported by the results of Study 5.3, which showed that forcing more ambivalent individuals to deliberate about their attitude intensified their feelings of ambivalence over time independently of whether the choice was delayed or not. Possibly, when forced to deliberate about the ambivalent topic without being given any information that helps resolve ambivalence, individuals confirm their ambivalence by thinking about both sides of the conflict without being able to give one side more weight than the other.

Another explanation for the increase in subjectively experienced ambivalence after deliberation may come from the Deliberation-without-attention hypothesis (Dijksterhuis, Bos, Nordgren, & van Baaren, 2006), according to which we make better decisions about complex issues when our conscious awareness is not directed at the task at hand (Dijksterhuis, Bos, Nordgren, & van Baaren, 2006; Nordgren & Dijksterhuis, 2011). Whereas Dijksterhuis and colleagues usually find that distraction from a choice results in choosing the objectively better option (e.g., Dijksterhuis et al., 2006) and that participants are more satisfied with their choice if they did not consciously deliberate about choice options (Dijksterhuis & van Olden, 2006), it may be that our participants were better able to resolve evaluative conflict when they were forced not to think about it deliberately. However, according to the Deliberation-without-attention hypothesis one’s “unconscious mental operations have to be trained on the problem” (Nordgren & Dijksterhuis, 2011), suggesting that one has to set the goal to make a choice before being distracted from the task in order for unconscious thought to be effective. Results of our third study, however, indicate that introducing the choice before (choice delay condition) or after (immediate choice condition) distraction from the conflict did not influence the effect of distraction, implying that distraction led to an overall decrease in experienced ambivalence independent of whether individuals were
unconsciously trained on the problem or not. This suggests that the observed relative difference between distraction and deliberation on experienced ambivalence may be more driven by the negative effect of deliberating about an unresolvable evaluative conflict than by a positive effect of being distracted and possibly deliberating unconsciously about the conflict. An interesting new research direction may be to investigate the effect of deliberation and distraction in combination with choice delay when participants are given new information that has the potential to reduce ambivalence. Future research will show whether the effect of a general preference for distraction as well as the increase in experienced ambivalence due to deliberation may be attenuated or even reversed in this case as participants are generally motivated to process information that helps resolve current evaluative conflict (Clark et al., 2008).

The third study also revealed that choice delay may generally not be adaptive in ambivalent decision-making. Where it had no effect on experienced ambivalence, individuals reported more negative affect when the choice was delayed independent of time use (i.e. distraction or deliberation). Even though some studies suggest that using delay in a purposeful way does not have the same negative consequences as other forms of delay (e.g., Chu & Choi, 2005), the outcomes of Study 5.3 suggest that the type of delay does not influence negative affect in ambivalent decision-making. This finding is in line with the common perspective on task delay as counterproductive and dysfunctional (Briody, 1980; cited in Steel 2007). However, the effectiveness, as well as preference, for choice delay in combination with either deliberation or distraction may be moderated by personality variables that were not assessed in the current studies such as the Need for cognition (Cacioppo & Petty, 1982) and Need for closure (Kruglanski, Webster, & Klem, 1993). Individuals high in need for closure may benefit even more from immediate decision-making than others, whereas individuals high in need for cognition may especially benefit from delaying their decision if they are able to deliberate about the ambivalent topic. Further research may determine whether personality variables influence the preference for and effectiveness of (the type of) choice delay in ambivalent decision-making.

Notably, the results thus show that delay and time use influence negative affect and self-reported ambivalence differently. This suggests that general negative affect and self-reported ambivalence should not be equated in ambivalence research. However, this effect may also have occurred because
both, negative affect and experienced ambivalence, were repeatedly measured after each other (see above). This may have led participants to report negative affect as a response to ambivalence on the subjective ambivalence measure, and see it as more detached from their general negative affective state. A measure more directed at the affective response to ambivalence (e.g., being irritated as a response to my opinion about the abortion law) may be more appropriate in this case. A general word of caution is needed due to the small effect sizes and limitations of the presented studies (e.g., only positive, univalent control conditions), which plead for drawing preliminary, but not definitive conclusions about the lacking interaction of choice delay and time use as well as their differential effects on negative affect and experienced ambivalence.

A difficulty this study shares with other studies on task delay is the challenge to manipulate delay in an appropriate way. This might be the reason why most studies on task delay measure postponement with self-report rather than manipulate it, making it difficult to derive causal relationships (van Eerde, 2003). In order to manipulate delay, we chose to control the time at which participants were told about the upcoming choice and keep the time between ambivalence manipulation and choice-moment constant for all participants. We believe this to be a useful simulation of task delay, and this manipulation allowed us to also look at the interactions of delay and deliberation. However, it may be argued that by giving immediate decision-makers very short notice they may have been startled, resulting in an increase in negative affect at the choice moment compared to decision-makers in the delay condition. The data, however, suggest otherwise by showing that negative affect before the choice did not differ between immediate and delayed decision-makers.

The presented studies are, to our knowledge, the first showing that choice delay is used as a coping strategy in ambivalent decision-making. The studies also reveal that delay of ambivalent decisions is not beneficial despite its popularity. This is in line with research on postponement showing negative consequences of unnecessary task delay in other domains such as health (Stead, Shanahan, & Neufeld, 2010; van Eerde, 2003), and academic performance (Tice & Baumeister, 1997). Additionally, the negative effects of delay on emotions were independent of whether participants engaged in distraction or deliberation in our study and suggest that at least in a decision-
making context in which no new information is offered, delaying a choice seems disadvantageous for the individual in terms of negative affect
Chapter 6
General discussion
Conflict is an intricate part of life. Often, this conflict is not with other people, but within ourselves: we are ambivalent about whether or not to go backpacking for a year, whether or not to change the first sentence of the paper we are writing, or whether or not to go running today. Using behavioral, self-report, and physiological (facial EMG, fMRI) measures, the research in this dissertation aimed to investigate how individuals are affected by, and deal with, ambivalence. We focused on three questions: First, what are the circumstances under which ambivalence results in negative affect as reflected by physiological and self-report measures? Second, how does contextual information help to reduce evaluative conflict in a forced choice situation? And third, is delaying a choice about an ambivalent topic a naturally occurring phenomenon, and what are its effects on negative affect and experienced ambivalence when the choice finally has to be made?

**Ambivalence and affect**

For many years it was thought that ambivalence elicits negative affect because it violates fundamental consistency motives (e.g., Briñol & Petty, 2005; McGregor, Newby-Clark, & Zanna, 1999). This idea is based on cognitive dissonance theory, which states that perceiving a mismatch between personal beliefs is experienced as aversive (Festinger, 1957), because “inconsistency serves as an epistemic cue for errors in one’s system of beliefs” (Gawronski, 2012, p. 652). Ambivalence represents such an inconsistency on a general attitude level (“I like and dislike Bob”) and was therefore suggested to be experienced negatively. However, this claim was not consistently supported by research findings. Some studies have shown a positive relation between ambivalence and negative affect (e.g., Hass, Katz, Rizzo, Bailey, & Moore, 1992), whereas others have revealed no relation, or even a reverse one with physiological arousal (Maio, Greenland, Bernard, & Esses, 2001). In Chapter 2 and 3 of this dissertation, we aimed to contribute to the clarification of this seemingly fuzzy relation between ambivalence and negative affect.

Some research has shown that conflicts are inherently aversive (Dreisbach & Fischer, 2012; Phaf & Rotteveel, 2012). Presenting conflicting Stroop stimuli (mismatch between ink color and word meaning) before neutral target stimuli, for example, leads to more negative judgments of the neutral targets
than presenting Stroop stimuli for which ink color and word meaning match (Fritz & Dreisbach, 2013). To investigate whether processing ambivalent stimuli has a similar effect due to the inherent conflict between opposingly valenced information, we assessed activity in two facial muscles (m. zygomaticus major, m. corrugator supercilii) continuously during the presentation of positive, negative, or positive and negative information about fictitious target persons (Chapter 3, task 1). The m. zygomaticus major pulls the corners of the mouth up into a smile and the m. corrugator supercilii lowers the eyebrows into a frown (van Boxtel, 2010). Zygomaticus major and corrugator supercilii have been reliably associated with positive and negative affect, respectively (Larsen, Norris, & Cacioppo, 2003). Results revealed that the affective response to ambivalent information was similar to the response to positive information: We found increased zygomaticus major and decreased corrugator supercilii activation for processing of ambivalent compared to negative information, suggesting that processing ambivalent information does not spontaneously elicit negative affect.

In order to identify factors that could determine when ambivalence results in negative affect, others have suggested that ambivalence-induced negative affect only occurs if individuals have to make a choice and therefore commit to one side of their attitude (van Harreveld, Rutjens, Rotteveel, Nordgren, & van der Pligt, 2009). In this case, negative affect was thought to be the result of anticipating negative consequences of one’s choice. Van Harreveld and colleagues indeed found that when participants were forced to make a dichotomous, consequential choice about an ambivalent topic, participants experienced more physiological arousal after having made the choice than participants who did not have to make a choice. Additionally, they found physiological arousal to be mediated by self-reported uncertainty about the outcomes of the choice, suggesting that physiological arousal was indeed negatively valenced in this study. However, in their study participants were asked to make a choice and this choice had relatively severe consequences (participants had to write an essay on their chosen opinion, which could be published in a student newspaper with their name attached to it), so that possible negative choice consequences may have inflated the negative affective response to ambivalence in the choice situation.

This study was used as a starting point for investigating the role of choice in ambivalence-induced negative affect. We started off by disentangling the
effect of having to make a choice from the effect of choice consequences. In the fMRI study reported in Chapter 2, we differentiated between choices that either had relatively minor or more severe consequences by manipulating the number of times participants were allowed to make an ‘incorrect’ choice before losing money. Participants made general “for/against” choices about ambivalent and univalent topics (e.g., “Are you for or against organ donation?”). Interestingly, the severity of choice consequences (i.e. how relevant each choice was in terms of gains and punishment) did not matter for the experience of ambivalence and did not alter neural processes underlying the decision process, suggesting that the severity of negative consequences is not necessarily the driving factor of negative affect when processing ambivalence. Next to finding activation in a broad network of regions including ACC, PCC, and TPJ, we found that having to make a choice about ambivalent stimuli engages brain regions related to the experience of negative emotional states and processing emotional salience, such as the insula (Menon & Uddin, 2010; Phan, Wager, Taylor, & Liberzon, 2002). Choice conflict on the basis of inconsistent (positive vs. negative) evaluations was thus sufficient to result in greater activation in emotion-related brain regions.

Ambivalence is negative when it turns into choice conflict

The previous findings suggested that ambivalence does not spontaneously elicit negative affect outside of a forced choice context and that if a choice has to be made about an ambivalent issue, it is associated with physiological arousal and greater activation in brain regions associated with emotion-processing. This raises the question what it is about having to make a choice that makes ambivalence more negative. According to Festinger (1957), inconsistencies are aversive and as suggested above, ambivalence represents such an inconsistency in that a person (or object, or issue) is simultaneously liked and disliked (e.g., “I like and dislike Bob”). However, liking and at the same time disliking Bob is based on more specific associations with Bob (“Bob is intelligent = I like Bob”, “Bob is dominant = I dislike Bob”). Yet, Bob being intelligent does not logically preclude Bob from being dominant, meaning that (on a more specific level) ambivalent evaluations do not have to be inconsistent. Looking at ambivalence this way suggests when it should result in negative affect and when it should not. A negative affective response to ambivalence is dependent on whether the ambivalent evaluations are inconsistent in the current choice situation, and thus create choice conflict.
Such a choice conflict can occur, for example, when someone asks you whether you are for or against organ donation (e.g., Chapter 2). Here, the inconsistency becomes clear, the question refers to your overall evaluation of organ donation, which is positive and negative and thus implies two different choices (e.g., “for and against”). However, when asked whether Bob (see above) is intelligent, the inconsistency of ambivalence (like and dislike) is present but irrelevant, because whether you think he is dominant has nothing to do with whether you find him intelligent or not. This suggests that it is not the choice itself that elicits negative affect, but that choice can serve as a catalyzer that stresses the inconsistency that ambivalence can represent. If the choice highlights an inconsistency among evaluations and thereby leaves the individual in suspense, ambivalence elicits negative affect. In short, ambivalence becomes negative when it turns into choice conflict.

This idea was tested in Chapter 3. Specifically, to investigate whether ambivalence only results in negative affect if ambivalence turns into choice conflict due to inconsistent evaluations, we manipulated the possibility to temporarily resolve inconsistency between evaluative tendencies in a choice context while measuring facial EMG. To do that we presented participants with positive and/or negative information about fictitious target persons. Subsequently we presented these target persons in different evaluative contexts, which either made one of the evaluative aspects more important for the choice at hand than the other (thereby decreasing inconsistency) or made both aspects similarly important (highlighting the inconsistency). For example, asking whether Bob, who is dumb and friendly, may be a good bartender may be relatively difficult to answer because both opposing characteristics (dumb, friendly) are relevant when judging the ability to be a bartender. In this case, the ambivalent characteristics create an inconsistency (dumb = not a good bartender, friendly = good bartender) and thus it presents participants with a choice conflict: each chosen option is inconsistent with one part of their evaluation. However, asking whether Bob would be good at providing others with financial advice may not create choice conflict and thus be relatively easy to answer as the evaluative context (good financial advisor) makes one of the characteristics (i.e. dumb) more relevant than the other. Evaluative context can thus help resolve ambivalence toward Bob in this choice situation without resolving ambivalence toward Bob in general (see also results on ambivalence measures, Chapters 3 and 4). Note that in both cases ambivalent information is presented before the evaluative context, so that
opposing evaluations are equally accessible before evaluative context is presented. Indeed we found that ambivalence was relatively more negative (reflected by a decrease in zygomaticus activation) when ambivalence created choice conflict, thus when ambivalent evaluations created an inconsistency in the current context that could not be resolved. When a choice had to be made, but evaluative context could help resolve conflict in the choice situation, participants showed less negative affect within 500ms after stimulus presentation compared to when ambivalence could not be resolved. Within 500ms after stimulus presentation, affective responses to situationally resolvable ambivalent information could not be distinguished from affective responses to univalent information. Notably, relatively more negative affect to unresolvable ambivalent stimuli in a choice situation was thus even found before participants had made a choice, suggesting that inconsistent evaluations can result in negative affect even before one has committed to one of the choice options. If, however, ambivalence is present but the conflict among opposite evaluations is irrelevant, either because no choice has to be made or because one of the evaluations is more important than the other in the current choice situation (what we have called ‘situationally resolvable ambivalence’), ambivalence does not elicit negative affect.

This leads us to the conclusion that ambivalence is indeed only negatively valenced when ambivalent evaluations are inconsistent and create a choice conflict. It is thus not the choice itself which makes ambivalence negative, but choice conflict on the basis of logically inconsistent evaluations.

The inconsistency between evaluative tendencies was manipulated by creating choice conflicts, and the role of inconsistency between evaluative tendencies outside of a choice context was not investigated in this dissertation (see General Discussion, Chapter 3). Finding negative affect due to inconsistency between evaluative tendencies is thus interpreted in the context of forced choice paradigms. In future studies it may be interesting to investigate whether presenting ambivalent, inconsistent information outside of a choice context may lead to similar effects. Likewise, it could be examined whether a choice context which also allows participants to choose a ‘mixed’ option yields these effects. Previous research has shown that expressing an opinion that is not your own leads to ‘typical’ cognitive dissonance effects, such as attitude change in the direction of the expressed attitude (Shaffer, 1975). Ambivalent individuals are forced to go against one side of their
evaluation in a dichotomous choice context (see Chapter 1), offering a ‘mixed’ choice option eliminates that aspect. If it is the unpleasantness of an inconsistency itself instead of having to go against one side of the attitude, then ambivalence should also result in negative affect without creating a choice conflict. However, this remains an empirical question for now.

The first conclusion is thus that ambivalence only results in negative affect (in some studies represented by a decrease in positive affect) if ambivalence creates a choice conflict based on inconsistent evaluations.

The complexity of ambivalence resolution is context-dependent

The findings reported in this dissertation confirm that processing ambivalent information is more complex than processing univalent information if respondents have to make a choice (Bargh, Chaiken, Govender, & Pratto, 1992; De Liver, van der Pligt, & Wigboldus, 2006; van Harreveld, van der Pligt, de Vries, Wenneker, & Verhue, 2004). In addition to the longer response times for ambivalent than univalent choices in Chapters 2 and 4, studies in these two chapters also indicate a relatively stronger engagement of several brain regions (ACC extending into IPFC, PCC/precuneus, TPJ, insula) when processing ambivalent information compared to processing univalent information. These findings are in line with the Iterative Reprocessing Model of Evaluation (IR Model; Cunningham, Zelazo, Packer, & van Bavel, 2007), which suggests that evaluations of a stimulus take place in several cycles during which information is interpreted and re-interpreted until a motivationally sufficient response has been reached. A motivationally sufficient response may be reached quickly if associations are of the same valence and thus not conflicting. Yet if associations are conflicting, these evaluations leave residual evaluative conflict so that additional evaluative cycles are necessary to reach a satisfactory response. This additional reprocessing of information is reflected in longer response latencies when evaluating ambivalent stimuli.

Extending previous findings, in Chapter 3 and 4 we investigated how contextual information (i.e. evaluative context) can help resolve evaluative conflict. Next to assessing how resolving conflict is reflected in affective responses measured by facial EMG, we were also interested in how the process of resolving conflict is reflected in neural activity measured by fMRI.
We thus used a similar person perception paradigm in the fMRI study reported in Chapter 4 as we did in Chapter 3. In line with the results of Chapter 3, showing that the affective response to ambivalence is influenced by the ability to resolve inconsistency through context within 500ms after stimulus presentation, we observed in Chapter 4 that brain regions were differentially activated depending on the possibility to situationally resolve ambivalence. We found increasing involvement of ACC, IPFC, and PCC/precuneus from univalent to situationally resolvable to situationally unresolvable ambivalent information in a choice context as indicated by how much ambivalence participants reported to experience about each trial. This finding was also mirrored by response times increasing from univalent to situationally resolvable to relatively unresolvable ambivalent choices.

We have interpreted these findings in line with Cunningham and Zelazo’s *Iterative Reprocessing Model of Evaluations* (2007). In line with this model, these findings suggest that evaluative information is processed in a dynamic fashion in order to reach an appropriate evaluative response, with ACC, PCC and prefrontal regions playing a central role in the detection of evaluative conflict and its resolution. Because of its suggested role in conflict detection and monitoring (e.g., Botvinick et al., 2004; Bush et al., 2000), we believe that ACC signals general evaluative conflict in the context of ambivalence. This may be accompanied by greater activation in PCC, which has been related to signaling the need for a change in behavioral strategies (Leech & Sharp, 2014). In line with the IR model, we suggest that evaluative information is then reprocessed in lateral prefrontal regions where evaluative context is taken into account to weigh evaluative aspects in order to resolve conflict. If this does not solve competing evaluative tendencies, ACC and PCC continue to be engaged and may signal the necessity for further reprocessing of information. Additionally, increased activity in the insula was observed during processing of situationally unresolvable ambivalent stimuli. This mirrors results of Chapter 3, where decreased m. zygomaticus major activity was found only for situationally unresolvable ambivalent stimuli in a choice context. Increased activity in the insula may suggest a relatively stronger negative affective response to ambivalent stimuli in a choice conflict.

The second conclusion of this dissertation is that neural regions are engaged based on the resolvability of evaluative conflict. ACC, PCC, and prefrontal regions seem to play a major role in the detection and resolution of ambivalence.
This line of reasoning is supported by the increased activation in ACC from situationally resolvable trials (> univalent trials) to situationally unresolvable trials (> resolvable trials). If evaluative context would be taken into account before detection of conflict, regions engaged by processing of situationally resolvable information should be similar to those engaged by processing of univalent information since only one aspect of the attitude representation would be relevant for the evaluation. The resolution of evaluative conflict is likely to be mediated by medial and lateral prefrontal regions (e.g., lateral frontal pole), yet this conclusion is tentative since these regions were found subthreshold and their engagement may depend on whether situational information is present that can help resolve ambivalence (see argumentation above).

These findings may have interesting implications for complex decision making across the lifespan. Research in developmental psychology has shown that the way in which humans make complex decisions changes over the lifespan, much of which is attributed to developmental changes in brain structure and functioning. For instance, ACC and dorsolateral PFC seem to develop until after the age of fourteen (Crone, Zanolie, van Leijenhorst, Westenberg, & Rombouts, 2008). We have found that these regions are both crucial in the detection and resolution of ambivalence (Chapter 2 and 4). Immaturity of these regions may have essential implications for the way in which ambivalence is processed by the (pre-)adolescent brain. It may be, for instance, that (pre-)adolescents are more tolerant to ambivalence, as they may need a more prominent evaluative conflict to detect ambivalence. When detected, (pre-)adolescents may have a greater difficulty to resolve evaluative conflict, and especially have a stronger emotional response due to the relatively mature limbic system (Casey, Jones, & Hare, 2008). Research may show whether indeed lesser activation in some and greater activation in other brain regions can predict the success with which ambivalence is resolved in the developing brain.

Important to note here is that fMRI has a relatively low temporal resolution as a tradeoff to its good spatial resolution, which leaves us speculating about the temporal order in which regions are engaged. Future research should use methods that allow for temporal tracing of evaluative processes to shed more light on the temporal development of evaluative responses and the interplay between medial and lateral prefrontal structures in resolving ambivalence.
Moreover, even though we suggest that evaluative context is taken into account after detection of evaluative conflict, this is based on an experimental design in which conflicting stimulus and context are presented simultaneously. However, research has unequivocally shown that context can shape the way a stimulus is perceived, especially if it is presented beforehand (e.g., Prinsen, de Ridder, & de Vet, 2013; Schwarz & Clore, 2003). Thus, presenting an evaluative context before the conflicting stimulus (e.g., “Do you think the following person may be a good financial advisor?”) may tune the individual toward the aspects that are relevant to answer this question, and thereby influence the emergence of evaluative conflict.

**When ambivalence cannot be resolved?**

Whereas in the previous paragraphs it was discussed that resolving ambivalence may be relatively easy and happen quickly in some contexts, in other contexts resolving ambivalence may be more cognitively complex (Chapter 4). Given that humans in general seek to minimize effort and maximize outcome (Principle of least effort; Zipf, 1949), it has been suggested that ambivalent individuals try other ways to cope with ambivalence that require less cognitive effort than resolving conflict (van Harreveld, van der Pligt et al., 2009). In the last empirical chapter a way of coping with ambivalence that does not necessarily require the individual to resolve ambivalence was explored: delaying an ambivalent choice. Surprisingly, choice delay has not previously been studied in ambivalent decision-making. In two field studies it was found that individuals are more likely to delay a choice about an ambivalent than a univalent topic. Subsequently, results of a lab study indicated that when given the possibility to delay an ambivalent choice, individuals more often chose to distract themselves rather than deliberate about the choice topic. Note that participants in all of these studies were not given any new information that could help them resolve ambivalence. It is thus possible that participants chose to distract themselves more often than deliberating about the topic because they believed that deliberating about the topic would only increase their evaluative conflict further. This interpretation is supported by the last study, in which deliberation increased and distraction decreased self-reported ambivalence for relatively ambivalent participants over the course of the experiment. Somewhat surprisingly, negative affect was not differentially affected by deliberation or distraction. Quite the contrary, we found that delaying any
choice, be it on a univalent or ambivalent topic, results in increasing self-reported negative affect after over time. So while ambivalence leads to choice delay, this appears to be a counterproductive coping strategy. It may, however, be that these results would look different if participants were given new information that can help reduce evaluative conflict. In most day-to-day choice situations, when individuals delay a choice they are able to search for new information that may help them to resolve ambivalence (e.g., go online and search for information about abortion before voting for or against a new abortion legislation). Research has indeed shown that individuals generally search information in such a way that helps them resolve ambivalence (Nordgren, van Harreveld, & van der Pligt, 2006). New information that can help resolve ambivalence could increase the benefits of delaying a choice, and might make individuals more willing to deliberate.

An interesting question is whether individuals first aim to resolve ambivalence using information in the evaluative context, or whether we are more likely to delay a choice before trying to resolve conflict. This question cannot be answered on the basis of the present data, however, given that effects of situational resolvability of ambivalence occur within 500ms after stimulus presentation, it seems likely that individuals first turn to evaluative context in order to resolve ambivalence. If this is unsuccessful and a choice can be delayed, they may try to delay the choice. Additionally, delay of a choice about an ambivalent topic may even be seen as situational resolution of ambivalence if it temporarily decreases the importance of the inconsistency between evaluative tendencies (i.e. “I am ambivalent about buying a house, but since I don’t have to think about it now, neither the positive nor the negative aspects are very important at the moment.”).

Therefore, the third conclusion is that ambivalent individuals are indeed more likely to delay a choice about an ambivalent topic. Additionally, if individuals are not given any new information, they prefer to distract themselves rather than deliberate about the topic in the time that is created through delaying. In general, delaying a choice about an ambivalent issue may be less beneficial than making a choice immediately.

The third conclusion may have important practical implications. People are often ambivalent about societal and political issues (e.g., eating meat, increasing taxes to support societal well-being, closing all coal-burning power
plants) and a general tendency to delay making up one’s minds on such issues can result in a misrepresentation of people’s opinion and involvement with an issue. One example may be fracking, in which water and chemicals are pumped into the earth at high pressures to gain access to natural gas that would otherwise be difficult to extract. This bears environmental risks, when at the same time it brings great financial benefits and independence from other countries with gas reserves. When people are ambivalent about fracking, they may delay resolving their ambivalence which could result in opinions being publicly expressed less often (e.g., demonstrations, debates) and lead politicians and decision-makers to believe that citizens are indifferent instead of ambivalent about the issue. Similarly, delaying in order to deliberate and integrate new information may also have negative implications despite good intentions to resolve ambivalence and make a well-grounded choice. Politicians in the US, for example, are still debating the environmental risks of fracking, in the meantime letting the process continue despite potential risks (Urbina, 2011). Furthermore, the results presented here propose that independent of ambivalence and distraction, if you cannot gather more information, it may be more beneficial to make a choice right away. This may even decrease ambivalence in a cognitive dissonance reduction kind-of-way.

The dynamics of ambivalence and its implications

Traditionally, attitudes are viewed as relatively stable evaluations expressing some kind of favor and disfavor (Eagly & Chaiken, 1998). A considerable amount of research has shown though that the expression of these relatively stable evaluations can be influenced by context (e.g., Ferguson & Bargh, 2003; Schwarz & Clore, 1983; van der Pligt, de Vries, Manstead & van Harreveld, 2000). On the basis of the research in this dissertation I believe that this is especially the case for ambivalent attitudes and that attitudinal ambivalence should not be seen as static, but as flexible and context-dependent. Contextual information determines how an ambivalent stimulus is processed and how affective responses to ambivalence develop over time by allowing individuals to weigh some evaluative aspect more than another (Chapters 3 and 4). Ambivalent attitudes thus allow for flexibility, in that the same object may be evaluated more positively in one, and more negatively in another context. Imagine having an overall ambivalent attitude towards cheesecake, in that you love the taste, but know it is relatively unhealthy. The situation then
determines whether you evaluate cheesecake more positively, more negatively, or experience evaluative conflict about it. You are probably less ambivalent about cheesecake on your birthday since cake is an essential part of birthdays! Similarly, you may also be less ambivalent about cheesecake on a Monday morning, because habits might dictate that you have muesli for a normal workday breakfast. Yet, on a Wednesday afternoon when you’re having coffee and the waiter asks whether you’d also like a cheesecake with your coffee, you are in a situation in which you may experience the full-blown conflict that ambivalence can create. A similar context-dependency of conflict experience has also been suggested by Jonas, Diehl, and Broemer (2000), who proposed that individuals experience ambivalence if context makes both sides of an ambivalent evaluation salient. Results of Chapter 3 suggest that it may not be salience of opposing evaluations that determines conflict experience, but conflict experience may depend on whether opposing evaluations are both relevant in a current context. If one side is made more relevant than the other, the ambivalent attitude structure stays the same, yet the evaluation that is expressed is based primarily on one of the evaluative components. The context-dependency of processing ambivalence also means that ambivalent stimuli should not always generate negative affect, but may also elicit positive affect dependent on the situation (cf. Chapter 3). Pillaud and colleagues, for example, suggest that individuals can express ambivalent attitudes to convey a positive social image, so that being ambivalent may sometimes even be a desirable state (Pillaud, Cavazza, & Butera, 2013). We have suggested that ambivalence only results in negative affect if it creates a choice conflict based on inconsistent evaluations.

Even though the final evaluation of an ambivalent stimulus is context-dependent, we found that processing ambivalent information is more complex even if context can help decrease evaluative conflict (Chapter 4). It seems that we notice a potentially relevant evaluative conflict which alerts us that we have to ‘do something’, and subsequently search for cues that help reduce conflict. In that sense, the response to ambivalent stimuli is similar to other conflicts or unexpected events such as obstacles. Being confronted with an obstacle, for example, can foster a broader perceptual scope and a search for solutions in the immediate environment (Marguc, Förster, & van Kleef, 2011; Marguc, van Kleef, & Förster, 2011), something also observed in Chapter 4, where the data suggest that evaluative context was taken into account after ambivalence was detected. Additionally, obstacles have been shown to foster
creativity as they disrupt the normal processing flow (Marguc, van Kleef, & Förster, 2014). In a similar vein, it has been suggested that consistency violations such as ambivalence (cf. Proulx, Inzlicht, & Harmon-Jones, 2012) stimulate creativity and that artists use periods of uncertainty as an inspiration for their work (Proulx & Inzlicht, 2012). It remains an empirical question whether ambivalence indeed fosters creativity and whether a disruption in processing flow, uncertainty, or the complexity of inconsistent evaluations may be the driving force behind such an effect. What becomes clear, though, is that ambivalence and an individual’s response to ambivalence are dynamic and context-dependent.

**To conclude**

There are many things we are ambivalent about, and sometimes it may even be harder to think of something that we are *not* (to some degree) ambivalent about. We may love going on holidays, but dislike unpacking our suitcase once back home; and we may love and at the same time dread adventure. Ambivalent attitudes have been interpreted as an inconsistency that individuals are inherently motivated to resolve, but research in this dissertation suggests that ambivalence is very pliable. We may in general be ambivalent about a topic, yet the context in which we encounter the topic may determine whether the inconsistency of ambivalence is expressed and translates into affective and behavioral changes that motivate us to resolve it. Different contexts have a substantial influence on the dynamics of ambivalence processing. Being able to simultaneously process positivity and negativity and weighing this information in line with contextual information is evolutionarily adaptive in that it allows for a flexible behavioral response (Larsen, McGraw, & Cacioppo, 2001). Looking at the temporal sequence in which ambivalence develops and can be resolved, research in this dissertation suggests that ambivalence only elicits negative affect when inconsistency between evaluations becomes relevant in a choice context. Subsequently, this response can be downregulated by taking evaluative context into account, or by delaying the choice.

The most important take-home message is thus that responses to ambivalence are dynamic and majorly influenced by situational variables. Contextual information determines how an ambivalent stimulus is processed, responded to and how affective responses to ambivalence develop over time by allowing individuals to weigh some evaluative aspect more than another. Attitudinal
ambivalence is thus not such a bad thing after all - ambivalence does not always elicit negative affect and it is often resolvable. However, if it is not, ambivalent decision-makers can experience the negative side of ambivalence, and coping by delaying a choice about an ambivalent topic seems to even increase negative affect. Attitudinal ambivalence thus can, but does not have to trigger a host of negative consequences, and I hope that future research will support the idea that ambivalence can also have positive effects dependent on context.


References


Schacht, A. Dimigen, O., & Sommer, W. (2010). Emotions in cognitive conflicts are not aversive but are task specific. *Cognitive, Affective and Behavioral Neuroscience, 10*, 349-356.


SOLVING AMBIVALENCE IN CONTEXT

The experience and resolution of attitudinal ambivalence

A couple of days ago I asked my sister what the first thing was that came to her mind when she thought of ambivalence. She said to me “Ambivalenz, jeder kennt’s!”, which freely translates into: “Ambivalence, everyone knows it!” (though it rhymes in German). Ambivalence is indeed something everyone knows – it is when we have positive and negative associations with a person, topic, object, or issue at the same time (Kaplan, 1972; Katz & Hass, 1988; Thompson, Zanna, & Griffin, 1995). We see the positive and negative side of globalization, we are for and against more CCTV cameras in the city, and we may like and dislike chocolate cake. Experiencing ambivalence can have implications for the way in which we process information and it can change affective and behavioral responses (for an overview, see van Harreveld, Nohlen, and Schneider, 2015). As mentioned in the beginning of this dissertation, experiencing ambivalence has, for example, been linked to instability in the evaluation of political candidates (Lavine, 2001), has been shown to predict relapse in smokers (Menninga, Dijkstra, & Gebhardt, 2011), has been thought to increase negative mood (Hass, Katz, Rizzo, Bailey, & Moore, 1992), and has been related to decreased customer loyalty (Olsen, Wilcox, & Olsson, 2005).

In the present dissertation I sought to further understanding of how individuals are affected by and subsequently deal with attitudinal ambivalence. Three main issues were distinguished. The aims were (1) to investigate the circumstances under which ambivalence elicits negative affect, (2) to examine the (neural) processes underlying the resolution of ambivalence in choice situations, and (3) to investigate delaying a choice as a way of coping with having to make a choice about an ambivalent topic. By combining physiological (fMRI, facial EMG), self-report, and behavioral methods in as well as outside of the lab, we aimed to shed further light on these questions. First, the circumstances under which ambivalence elicits negative affect were examined using physiological (fMRI, facial EMG) methods (Chapter 2 and 3). Second, the role of evaluative context in processing of ambivalence was examined with a specific focus on the development and resolution of choice conflict (Chapter 3 and 4). Third, choice delay was examined as a way of coping with ambivalence that does not necessarily involve resolving
ambivalence, but has been argued to reduce negative affect by distraction from ambivalence (Chapter 5).

In Chapter 2 we investigated brain activity underlying the processing of ambivalent information in a choice context. We predicted and found that making dichotomous (for/against) choices about ambivalent (e.g., organ donation) compared to univalent (e.g., holidays, genocide) topics engages a broad network of brain regions, including regions that are associated with the experience of negative emotional states (i.e. insula; Critchley, Elliott, Mathias, & Dolan, 2000) and regions related to conflict monitoring and detection (i.e. anterior cingulate cortex; Botvinick, 2007). In this study, we also manipulated the severity of choice consequences under the hypothesis that ambivalence elicits negative affect in choice situations due to the anticipation of negative consequences of an uncertain choice. Notably, choice consequences did not alter neural processes underlying ambivalent decision-making or self-reported measures of conflict experience, suggesting that the severity of negative consequences is not the driving factor of negative affect when processing ambivalence. The data revealed that making choices about ambivalent compared to univalent topics resulted in more activity in the anterior cingulate cortex (ACC) extending into the lateral prefrontal cortex, the insula, the posterior cingulate cortex (PCC)/precuneus, and the temporal parietal junction (TPJ). The PCC has been related to signaling the need for a change in behavioral strategies (Leech & Sharp, 2014). It is functionally connected to the TPJ, and together both regions have been suggested to be more engaged by social and cognitive problem solving, for example complex decision-making processes that call for an analysis of oneself in another perspective, time, or place (Buckner & Carroll, 2007; Mars et al., 2012). This may suggest that these regions are more engaged during ambivalent decision-making because different choice outcomes have to be considered in order to make a decision that yields the most preferable outcome for oneself.

In Chapter 3, we focused on the role of choice and evaluative context in eliciting a negative affective response using facial EMG. Facial EMG is a physiological measure that assesses activity in facial muscles. Stronger activity in two facial muscles, the musculus zygomaticus major and the musculus corrugator supercilii, has been reliably associated with positive and negative affect, respectively (Larsen, Norris, & Cacioppo, 2003). The zygomaticus major pulls the corners of the mouth up into a smile and the corrugator supercilii
lowers the eyebrows into a frown (van Boxtel, 2010). Using a person perception paradigm, we presented participants with positive (e.g., friendly, intelligent), negative (e.g., jealous, dominant), or positive and negative information (e.g., intelligent, dominant) about different target persons. In two tasks, participants were either exposed to the information without having to respond (task 1), or participants made dichotomous choices (yes/no) about the target persons (task 2). In the second task, evaluative context was manipulated so that the inconsistency between ambivalent information could either be resolved (e.g., “Bob is intelligent and dominant. Do you think he can write a good research paper?”) or was more difficult to resolve (e.g., Bob is intelligent and dominant. Do you think Bob is a good collaborator?”). Results showed that ambivalent information in the absence of a forced choice situation elicits the same direct affective response as positive stimuli, participants showed more zygomaticus and less corrugator activation than to negative stimuli (task 1). Affective responses to ambivalence when a choice had to be made were influenced by evaluative context (task 2). Specifically, ambivalence only led to a relative decrease in positive affect when evaluative context did not help resolve the inconsistency between ambivalent evaluations and created a choice conflict. When the same ambivalent information was presented in a context in which the opposing evaluations were not logically inconsistent (i.e. one of the characteristics was more relevant for the choice than the other and inconsistency was temporarily resolved), participants reported to experience lower levels of conflict and displayed less negative affect. Chapter 3 thus suggests that ambivalence only leads to relatively more negative affect (i.e. a decrease in positive affect) when ambivalent information is inconsistent in a current choice situation, and thus creates choice conflict.

Chapter 4 built forth on this idea and investigated the neural processes underlying ambivalence resolution through evaluative context. Again using a person perception paradigm (see Chapter 3, task 2), we replicated the engagement of brain regions found more activated during ambivalent compared to univalent decision-making in Chapter 2 (i.e. ACC, IPFC, insula, PCC/precuneus, TPJ). Extending these findings, we observed increasing involvement of ACC, IPFC, and PCC/precuneus for processing of univalent to situationally resolvable to situationally unresolvable ambivalent information in a choice context. These findings were mirrored by response times increasing from univalent to situationally resolvable to relatively
unresolvable ambivalent choices, suggesting that choices became more complex dependent on whether information was ambivalent and whether that ambivalence could be resolved by taking evaluative context into account. These results indicate that neural regions are engaged based on the resolvability of evaluative conflict, with ACC, PCC, and prefrontal regions playing a major role in the detection and resolution of ambivalence.

However, evaluative context cannot always help resolve ambivalence. The Model of ambivalence-induced discomfort (MAID; van Harreveld, van der Pligt, & de Liver, 2009) suggests that individuals try and delay a choice about an ambivalent issue in order to cope with the unpleasant situation of having to make a dichotomous choice. Chapter 5 describes two field studies and two lab studies in which choice delay was investigated as a coping strategy. The two field studies indicated that individuals are indeed more likely to delay choices about a topic they are ambivalent about compared to choices about a univalent topic. Additionally, when given the possibility to delay an ambivalent choice, individuals more often chose to distract themselves rather than deliberate about the choice topic. The last study in this chapter examined the effects of distraction versus deliberation during choice delay. It specifically focused on negative affect and self-reported experience of ambivalence when the choice finally has to be made. Results showed that choice delay leads to more negative affect after compared to before the choice. This is the case both when delay is used for distraction and when it is used for deliberation. However, delaying the choice does not reduce or enhance self-reported ambivalence. Independent of whether the choice was delayed, deliberation increased and distraction decreased self-reported ambivalence for relatively ambivalent participants after compared to before the choice. The results thus suggest that delaying a choice is commonly used in order to deal with an ambivalent choice, however, delaying a choice is not necessarily beneficial for ambivalent decision-makers.

Taken together, results of this dissertation suggests that how individuals are affected by and deal with ambivalence is not static, but context-dependent. Context may determine whether the inconsistency of ambivalence is expressed and translates into affective and behavioral changes that motivate us to resolve it. Contextual information determines how an ambivalent stimulus is processed, responded to and how affective responses to ambivalence develop over time by allowing individuals to weigh some
evaluative aspect more than another. Attitudinal ambivalence is thus not such a bad thing after all - ambivalence does not always elicit negative affect and it is often resolvable. However, if it is not, ambivalent decision-makers can experience the negative side of ambivalence, and coping by delaying a choice about an ambivalent topic seems to even increase negative affect. Attitudinal ambivalence thus can, but does not have to trigger a host of negative consequences, and I hope that future research will support the idea that ambivalence can also have positive effects dependent on context.
SOLVING AMBIVALENCE IN CONTEXT
The experience and resolution of attitudinal ambivalence

Een paar dagen geleden vroeg ik mijn zus wat er als eerste in haar opkomt als zij aan ambivalentie denkt. Haar antwoord was: “Ambivalenz, jeder kennt’s!”, wat vertaald kan worden naar: “Ambivalentie, iedereen kent het!”.

Ambivalentie is inderdaad iets dat iedereen kent – het vertegenwoordigt de aanwezigheid van associaties met een persoon, object, of onderwerp die tegelijkertijd positief en negatief zijn (Kaplan, 1972; Katz & Hass, 1988; Thompson, Zanna, & Griffin, 1995). Zo zien we bijvoorbeeld de positieve en negatieve kant van globalisatie, we zijn voor en tegen meer camera’s in openbare ruimtes, en misschien vinden we chocolade taart lekker en ongezond.

Onderzoek heeft laten zien dat het ervaren van ambivalentie invloed kan hebben op de manier waarop informatie verwerkt wordt, maar ook affect en gedrag kan beïnvloeden (voor een overzicht, zie van Harreveld, Nohlen, en Schneider, 2015). Het ervaren van ambivalentie is bijvoorbeeld in verband gebracht met schommelingen in de beoordelingen van politici (Lavine, 2001), terugval bij rokers die proberen te stoppen (Menninga, Dijkstra, & Gebhardt, 2011), en met minder loyaliteit van klanten (Olsen, Wilcox, & Olsson, 2005).

In dit proefschrift wordt beoogd meer inzicht te krijgen in de manier waarop mensen beïnvloed worden door, en omgaan met, ambivalentie. Hierbij heb ik me vooral gericht op de vraag wanneer ambivalentie negatief affect oproept, hoe context kan helpen bij het oplossen van ambivalentie, en wat er gedaan kan worden als ambivalentie in de huidige keuze-context niet opgelost kan worden. In de eerste twee empirische hoofdstukken werd met behulp van fMRI en facial EMG onderzocht wanneer ambivalentie tot negatief affect leidt (Hoofdstuk 2 en 3). Vervolgens werd gekeken hoe een keuze-context waarin ambivalente informatie wordt verwerkt de ontwikkeling en oplossing van keuze conflicten kan beïnvloeden (Hoofdstuk 3 en 4). In het laatste hoofdstuk werd het nut van het uitstellen van een keuze over een ambivalent onderwerp getoetst door te onderzoeken hoe uitstel het ervaren van ambivalentie en negatief affect over tijd beïnvloedt (Hoofdstuk 5).

In Hoofdstuk 2 werd onderzocht welke hersengebieden betrokken zijn bij het verwerken van ambivalente informatie in een keuze context. We verwachtten en vonden dat het maken van dichotome (voor/tegen) keuzes over
ambivalente (bijv. orgaandonatie) in vergelijking met univalente (bijv.
vakantie, genocide) onderwerpen een breed netwerk van hersengebieden
activeert, onder andere breingebieden die geassocieerd worden met het
ervaren van negatieve emoties (bijv. insula; Critchley, Elliott, Mathias, &
Dolan, 2000) en gebieden die betrokken zijn bij het herkennen en monitoren
van conflict (anterior cingulate cortex; Botvinick, 2007). Gebaseerd op het idee
dat ambivalentie negatief affect oproept omdat negatieve gevolgen van een
keuze geanticipeerd worden, werd ook de aannemelijkheid van negatieve
gevolgen van de keuzes gemanipuleerd. Dit had echter geen invloed op de
zelf-gerapporteerde ervaring van conflict en had ook geen invloed op de
neurale processen die ten grondslag liggen aan het maken van ambivalente
keuzes. Dit suggereert dat de anticipatie van negatieve gevolgen niet per se
verantwoordelijk is voor negatief affect bij het verwerken van ambivalentie
informatie. De studie laat zien dat het maken van keuzes over ambivalente
vergeleken met univalente onderwerpen tot meer activiteit leidt in de anterior
cingulate cortex (ACC) en laterale prefrontale cortex, de insula, de posterior
cingulate cortex (PCC)/precuneus, en de temporal parietal junction (TPJ). De
PCC wordt geassocieerd met het signaleren van de noodzaak om gedrag aan
tee passen (Leech & Sharp, 2014) en is functioneel verbonden met de TPJ. Er
wordt verondersteld dat beide gebieden betrokken zijn bij, bijvoorbeeld,
complexe besluitvormingsprocessen waarbij het nodig is om verschillende
perspectieven in te nemen (Buckner & Carroll, 2007; Mars et al., 2012). Dit zou
erop kunnen wijzen dat deze gebieden meer betrokken zijn bij het maken van
ambivalente keuzes omdat verschillende mogelijke keuze-uitkomsten
overwogen moeten worden om vervolgens de meest voordelige keuze te
maken.

In Hoofdstuk 3 werd onderzocht hoe het maken van een keuze en de keuze-
context waarin informatie gepresenteerd wordt, affectieve responsen op
ambivalente en univalente informatie beïnvloedt. Affectieve responsen
werden gemeten met facial EMG, dit is een fysiologische maat die de activiteit
in gezichtsspieren kan meten. Sterkere activiteit in twee gezichtsspieren, de
musculus zygomaticus major en de musculus corrugator supercili, geeft een
indicatie van positief en van negatief affect (Larsen, Norris, & Cacioppo,
2003). De zygomaticus major trekt de mondhoeken omhoog in een glimlach
en de corrugator supercili duwt de wenkbrauwen omlaag in een frons (van
Boxtel, 2010). Tijdens het onderzoek werden deelnemers gepresenteerd met
positieve (bijv. vriendelijk, intelligent), negatieve (bijv. jaloers, dominant), of
positieve en negatieve informatie (bijv. Intelligent, dominant) over verschillende target personen. In twee taken werden de deelnemers ofwel blootgesteld aan de informatie zonder dat ze gevraagd werden om op de informatie te reageren (taak 1), of de deelnemers werden gevraagd om dichotome keuzes (ja/nee) te maken over de personen (taak 2). In deze tweede taak werd de keuze-context gemanipuleerd zodat de inconsistentie tussen ambivalente informatie opgelost kon worden (bv. “Bob is intelligent en dominant. Denk je dat hij een goed onderzoeksverslag kan schrijven?”), of het moeilijker was om de inconsistentie op te lossen (bv. “Bob is intelligent en dominant. Denk je dat Bob een goede medewerker zou zijn?”). De resultaten lieten zien dat ambivalente informatie dezelfde directe affectieve respons opwekt als positieve informatie wanneer proefpersonen geen keuze hoefden te maken; deelnemers lieten meer zygomaticus en minder corrugator activatie zien vergeleken met de activatie tijdens het verwerken van negatieve informatie (taak 1). De affectieve respons op ambivalente informatie als er wel een keuze gemaakt moest worden was afhankelijk van de context waarin de informatie gepresenteerd werd. Ambivalentie leidde tot een verlaging van positief affect wanneer de keuze-context de inconsistentie tussen ambivalente beoordelingen niet kon oplossen. Echter, wanneer dezelfde ambivalente informatie in een context gepresenteerd werd waarin de tegenovergestelde beoordelingen niet inconsistent waren (i.e. één van de kenmerken was relevant voor de keuze dan het ander kenmerk, waardoor de inconsistentie tijdelijk opgelost kon worden), rapporteerden proefpersonen minder conflict en lieten ze ook minder negatief affect zien. Hoofdstuk 3 suggereert dus dat ambivalentie alleen tot relatief meer negatief affect leidt (i.e. minder positief affect), wanneer ambivalente informatie in de keuzesituatie inconsistent is en daardoor een keuzecompact optreedt.

De studie in hoofdstuk 4 bouwt voort op dit idee; hier werden de neurale processen onderzocht die ten grondslag liggen aan het oplossen van ambivalentie in een bepaalde keuze-context. Ook in dit hoofdstuk werd gebruik gemaakt van een persoonsperceptie paradigma (zie Hoofdstuk 3, taak 2). Ten eerste werden de resultaten van Hoofdstuk 2 gerepliceerd; ACC, IPFC, insula, en PCC/precuneus waren sterker geactiveerd tijdens het maken van keuzes over ambivalente vergeleken met univalente informatie. Bovendien vonden we een toename in activatie van ACC, IPFC, en PCC/precuneus voor het verwerken van univalente vergeleken met contextueel oplosbare ambivalente informatie, en vervolgens weer een toename in activatie voor
minder oplosbare ambivalente keuzes. Dit suggereert dat keuzes complexer worden afhankelijk van de valentie van de informatie (univalent/ambivalent) en afhankelijk van de oplosbaarheid van ambivalentie in de context van de keuze. De resultaten laten zien dat breingebieden geactiveerd worden op basis van de oplosbaarheid van evaluatief conflict, en suggereren dat ACC, PCC, en prefrontale gebieden een belangrijke rol spelen in het herkennen en oplossen van ambivalentie.

De context waarin informatie beoordeelt wordt kan echter niet altijd helpen bij het oplossen van ambivalentie. Het Model of ambivalence-induced discomfort (MAID; van Harreveld, van der Pligt, & de Liver, 2009) veronderstelt dat keuzes over ambivalente onderwerpen uitgesteld worden om vervelende keuze situaties te vermijden. In Hoofdstuk 5 worden twee veldstudies en twee labstudies beschreven waarin het uitstellen van een keuze als coping strategie bij ambivalentie werd onderzocht. De twee veldstudies laten zien dat keuzes over ambivalente onderwerpen inderdaad vaker worden uitgesteld dan keuzes over univalente onderwerpen. Bovendien werd gevonden dat wanneer mensen de mogelijkheid hebben om een ambivalente keuze uit te stellen, ze eerder kiezen voor afleiding dan deliberatie over het onderwerp. In de laatste studie van dit hoofdstuk werd het effect van afleiding en deliberatie tijdens het uitstellen van een keuze onderzocht door te kijken naar zelf-gerapporteerd negatief affect en ervaren ambivalentie op het moment dat de keuze gemaakt moet worden. De resultaten lieten zien dat het uitstellen van een keuze tot een toename in negatief affect leidt na het maken van de keuze. Dat was het geval wanneer deelnemers werden afgeleid of gevraagd over het onderwerp na te denken. Echter, het uitstellen van een keuze liet geen effect zien op ervaren ambivalentie. Voor relatief ambivalente proefpersonen leidde deliberatie tot een toename, en afleiding tot een afname in ambivalentie na vergeleken met voor de keuze onafhankelijk daarvan of de keuze uitgesteld werd of niet. De resultaten suggereren dus dat het uitstellen van een keuze inderdaad vaak voorkomt, maar niet per se voordelig is voor de ambivalente beslisser.

Concluderend kan gesteld worden dat de resultaten van dit proefschrift er op wijzen dat de manier waarop individuen beïnvloed worden en omgaan met ambivalentie niet statisch, maar contextafhankelijk is. Context kan bepalen of de inconsistentie van ambivalentie tot uitdrukking komt en vertaald wordt naar veranderingen in affect en gedrag die de basis zijn voor de motivatie om ambivalentie op te lossen. Contextuele informatie bepaalt hoe een
ambivalente stimulus verwerkt wordt, hoe daarop gereageerd wordt en contextuele informatie bepaalt hoe de affectieve response zich over tijd ontwikkelt door de verschillende weging van evaluatieve aspecten te ondersteunen of te voorkomen. Ambivalentie is dus niet per definitie iets negatiefs – het leidt niet altijd tot negatief affect en het kan vaak opgelost worden. Echter, wanneer het niet opgelost kan worden, ervaren ambivalente beslissers de negatieve kant van ambivalentie, en het uitstellen van een keuze over een ambivalent onderwerp kan negatief affect zelfs nog versterken. Context is dus bepalend voor de manier waarop ambivalente informatie verwerkt wordt en hoe ermee omgegaan wordt.
Contributions to empirical chapters

Chapter 2


The study was designed by H.U.N, F.v.H, and E.A.C. Data were collected by H.U.N and G.J.L, and analyzed by H.U.N and E.A.C. The article was written by H.U.N and all co-authors provided valuable comments on the manuscript.

Chapter 3


The study was designed by H.U.N, F.v.H, J.T.L, and M.R. Data were collected and analyzed by H.U.N. The article was written by H.U.N and all co-authors provided valuable comments on the manuscript.

Chapter 4


The study was designed by H.U.N, F.v.H, E.A.C., and W.A.C. Data were collected by H.U.N, and analyzed by H.U.N and W.A.C. The article was written by H.U.N and all co-authors provided valuable comments on the manuscript.

Chapter 5


The studies were designed by H.U.N, F.v.H., J.v.P., and M.R. Data were collected and analyzed by H.U.N. The article was written by H.U.N and all co-authors provided valuable comments on the manuscript.

The PhD project was funded by NWO (400-08-186).
Time flies when you’re writing a dissertation. Even though it might feel like you just started and still don’t know as much as you want to, you have hopefully learned much more than you initially thought. This is often thanks to the many people that have directly or indirectly been a part of the process. The number of people I would like to thank for their support during the last years has accumulated considerably. Here goes.

First, my advisors: Frenk, Mark, Joop, and Agneta. Frenk, your support and input on this project have been invaluable. You were at SPSP when I started my first day at the UvA and I arrived at my desk with a huge pile of articles and a little note: ‘basic literature’. I have to admit that I was slightly intimidated at that point..! Since that day you gave me the freedom to make the project my own and you’ve been a reliable source of ideas, advice, and motivation. Your optimism about the projects we started as well as your readiness to put me in contact with anyone who may be willing to teach me something I was interested in, has made this dissertation project an exciting, educational, and enjoyable experience. Thank you for letting me learn from you, for your critical but encouraging feedback, your quick replies to any email, and for your trust – I’m looking forward to the next years of collaboration! Mark, your critical eye provided a fresh perspective to our ideas and has often made a line of argumentation more focused and convincing. Thank you for your advice, for introducing me to the use of physiological measures and for consistently challenging my point of view. I would also like thank Joop, for his support, insights and his humor during the time we worked together. When I nervously entered his office for my evaluation talk at the end of my first year, he picked up the phone to call my then-roommate Marc and asked him to start packing my stuff “so she can leave quietly”, then laughed out loud. I am sad that he will not be at the defense of this dissertation that also exists due to his contribution. Agneta, you entered the project at the very last stage, thank you for your trust and your willingness to be my promoter.

I was also very lucky to be able to collaborate with Eveline Crone and Wil Cunningham. Eveline, you introduced me to neuroimaging and I wouldn’t have been able to run my first MRI study without you. Thank you for taking the time to go through Eprime, matlab, and SPM code with me, for looking at and explaining data and for your constructive feedback on our papers. Wil, you entered the project someway half-through and have shaped many ideas
Acknowledgement

with your knowledge and insights. Your enthusiasm about theoretical ideas is contagious and inspiring! Thank you also for your hospitality in Toronto. I have learned immensely from both of you, and I hope we will be able to keep collaborating in the future.

And now to my current and former SP colleagues at the Uva – thank you all for your feedback throughout the years, the interesting discussions, sparking of ideas, and, of course, the gezelligheid, borrels and pizza-after-borrels on Roetersstraat. I’d like to mention some people in particular. Not to forget are, of course, the (current and former) members of the uncertainty lab group: Joop, Frenk, Michiel, Bastiaan, Iris, Lottie, Daniel, David, and Jonas - as well as the Regulation of behavior/Social Cognition labgroup: Rob, Kai, Mark, Nils, Suzanne, Daniela, Tim, Inge, and Lisanne – I enjoyed our discussions and it was fun sharing thoughts and ideas at our sometimes more, sometimes less regular meetings. Rob, it was your class on ‘Attitudes’ in Nijmegen that initially sparked my interest for doing research on attitudes and social cognition, and, of course, thank you for putting in a good word in Amsterdam! For academic, but also very non-academic fun - Daniela, Milena, Liesbeth, and Janina – thanks for the girl nights and talking about some academic, but mostly ‘non-academic stuff’. Mila, who would have thought we’d become colleagues in Amsterdam after sharing a house in Nijmegen! Thank you for being a great friend, almost-neighbour, and of course my paranymph. Liesbeth, you have a great ability to stay focused even if things don’t always go as planned, I’m crossing my fingers for the last pages of your dissertation and thanks for being my paranymph despite it being the stressful last months. Daniela and Tim – our lunch and coffee-walks at the Amstel and discussions on ‘what it all means’ sind Gold wert, what would I do without them. Also Tim, thanks for putting in all that time to make a perfect cover, I owe you one! De ‘sportmeisjess’: Liesbeth and Lisanne – jumping over benches with you kept me sane during the writing phase – we will get that six-pack at some point! Janina, somehow our conversations always turn philosophical (in a good and confusing way), thanks for many studio-k nights: we’ll figure life out in the end, until then, let’s ‘go with the flow’. Bästiaän, thanks for the coffee and sometimes nonsense, but more often sense chats. Not to forget my current and former roomies (David, Lisanne, and Sanne; and Coen, Daniel, Effie, Lottie, Lukas, and Marc) for various coffee breaks, chats, and (especially in the early years) table tennis rounds. You have all made the UvA feel like a second home. Also I would like to thank my students, especially Dafina Petrova and Ard Barends, who helped gather
some of the data and special thanks also go to Bert Molenkamp for helping with the technical tricks of EMG. Last but not least, thanks to Karin and Ho Jung for their general help and support.

Before and during my time as a PhD student I have met many other people who made studying, lab-sitting, workshops, summer schools and conferences not only valuable on a content-level, but also a lot of fun: Anne, Claire, Gert-Jan, Jimmy, Maartje, Reine, Sanne, Sindhu, Vincent, the Remics 2011 group, and all the SPSP summer school people (not forgetting an additional banana for the people of the bananarama project). I hope to continue seeing you at more conferences to come. I also learned a lot from and had a great time with the ASPO-dissertation committee 2012 and 2013, and thoroughly enjoyed the KLI workshops during my time as a PhD student. Sanne – we were the two guinea pigs starting the RM mid-year, secretaries together, coffees, chats, and road-tripping through the US. Even though we aren’t at the same university anymore, I hope we keep seeing each other regularly. Reine, conference roomie during at least three (four?) conferences, you make a feestje of each one of them (praatje of zwembad?). Anne, newbies during the social neuroscience workshop in Ghent – looking forward to your six months back in Amsterdam to revive our cooking nights.

I was lucky to meet some great people in Amsterdam who helped me balance research and the outside world: Ai, Alberto, Ana and Romulo, Catharina and Gaëtan, Helen, Janina and Philipp, Milena and João, Max, and Floor: let there be many more boat tours, festivals, Roest evenings, swim sessions, and game nights to come. Other people have been there ‘forever’: The, dieses Jahr feiern wir unseren 25ten – wir haben schon so viel zusammen durchgemacht, ich weiß gar nicht wo ich anfangen soll. Judith, schön, dass wir immer nur eine SMS voneinander entfernt sind, egal wo wir gerade sind. Auch wenn wir drei in verschiedenen Städten wohnen, fangen wir immer da an wo wir aufgehört haben, danke für eure Freundschaft, Ehrlichkeit, euer Relativierungsvermögen, und eure Verrücktheit. Henrik, huisgenootjes in Holland?? Schön, dass wir uns nicht aus den Augen verloren haben. Domi und Ulrike, manchmal aus den Augen, aber nie aus dem Sinn! Wir schaffen es doch immer wieder uns unregelmässig, regelmässig, spontan, geplant zu sehen – ich freu mich jetzt schon aufs nächste Mal! Erik, tack för allt - moving countries, changing jobs, for being there, but mostly for being who you are. Do I have to say more? You’re .. the bomb.

Amsterdam, August 2015
The “Kurt Lewin Institute Dissertation Series” started in 1997. Since 2013 the following dissertations have been published in this series:

2013-1: Annemarie Hiemstra: *Fairness in Paper and Video Resume Screening*
2013-2: Gert-Jan Lelieveld: *Emotions in Negotiations: The Role of Communicated Anger and Disappointment*
2013-3: Saar Mollen: *Fitting in or Breaking Free? On Health Behavior, Social Norms and Conformity*
2013-4: Karin Menninga: *Exploring Learning Abstinence Theory: A new theoretical perspective on continued abstinence in smoking cessation*
2013-5: Jessie Koen: *Prepare and Pursue: Routes to suitable (re-)employment*
2013-6: Marieke Roskes: *Motivated creativity: A conservation of energy approach*
2013-7: Claire Marie Zedelius: *Investigating Consciousness in Reward Pursuit*
2013-8: Anouk van der Weiden: *When You Think You Know What You're Doing: Experiencing Self-Agency Over Intended and Unintended Outcomes*
2013-9: Gert Stulp: *Sex, Stature and Status: Natural Selection on Height in Contemporary Human Populations*
2013-10: Evert-Jan van Doorn: *Emotion Affords Social Influence: Responding to Others' Emotions In Context*
2013-11: Frank de Wit: *The paradox of intragroup conflict*
2013-12: Iris Schneider: *The dynamics of ambivalence: Cognitive, affective and physical consequences of evaluative conflict*
2013-13: Jana Niemann: *Feedback Is the Breakfast of Champions, but It Can Be Hard to Digest: A Psychological Perspective on Feedback Seeking and Receiving*
2013-14: Serena Does: *At the heart of egalitarianism: How morality framing shapes Whites' responses to social inequality*
2013-15: Romy van der Lee: *Moral Motivation Within Groups*
2013-16: Melvyn Hamstra: *Self-Regulation in a Social Environment*
2013-17: Chantal den Daas: *In the heat of the moment: The effect of impulsive and reflective states sexual risk decisions*
2013-18: Kelly Cobey: *Female Physiology Meets Psychology: Menstrual Cycle and Contraceptive Pill Effects*
2013-19: Ellen van der Werff: *Growing environmental self-identity*
2013-20: Lise Jans: *Reconciling individuality with social solidarity: Forming social identity from the bottom up*
2013-21: Ruth van Veelen: *Integrating I and We: Cognitive Routes to Social Identification*
2013-22: Lottie Bullens: *Having second thoughts: consequences of decision reversibility*
2013-23: Daniel Sligte: *The functionality of creativity*
2014-01: Marijn Stok: *Eating by the Norm: The Influence of Social Norms on Young People's Eating Behavior*
2014-02: Michèle Bal: *Making Sense of Injustice: Benign and Derogatory Reactions to Innocent Victims*
2014-03: Nicoletta Dimitrova: *Rethinking errors: How error-handling strategy affects our thoughts and others' thoughts about us*
2014-04: Namkje Koudenburg: *Conversational Flow: The Emergence and Regulation of Solidarity through social interaction*
2014-05: Thomas Sitser: *Predicting sales performance: Strengthening the personality – job performance linkage*
2014-06: Goda Perlaviciute: *Goal-driven evaluations of sustainable products*
2014-07: Said Shafa: *In the eyes of others: The role of honor concerns in explaining and preventing insult-elicited aggression*
2014-08: Felice van Nunspeet: Neural correlates of the motivation to be moral
2014-09: Anne Fetsje Sluis: Towards a virtuous society: Virtues as potential instruments to enhance
2014-10: Gerdien de Vries: Pitfalls in the Communication about CO2 Capture and Storage
2014-12: Hans Marien: Understanding and Motivating Human Control: Outcome and Reward Information in Action
2014-13: Daniel Alink: Public Trust: Expectancies, Beliefs, and Behavior
2014-14: Linda Daphne Muusses: How Internet use may affect our relationships: Characteristics of Internet use and personal and relational wellbeing
2014-16: Martijn Keizer: Do norms matter? The role of normative considerations as predictors of pro-environmental behavior
2015-01: Maartje Elshout: Vengeance
2015-03: Dagmar Beudeker: On regulatory focus and performance in organizational environments
2015-04: Charlotte Koot: Making up your mind about a complex technology: An investigation into factors that help or hinder the achievement of cognitive closure about CCS
2015-05: Marco van Bommel: The Reputable Bystander: The Role of Reputation in Activating or Deactivating Bystanders
2015-06: Kira O. McCabe: The Role of Personality in the Pursuit of Context-Specific Goals
2015-07: Wiebren Jansen: Social inclusion in diverse work settings
2015-08: Xiaoqian Li: As time goes by: Studies on the subjective perception of the speed by which time passes
2015-09: Aukje Verhoeven: Facilitating food-related planning. Applying metacognition, cue-monitoring, and implementation intentions
2015-10: Jasper de Groot: Chemosignaling Emotions: What a Smell can Tell
2015-12: Bart de Vos: Communicating Anger and Contempt in Intergroup Conflict: Exploring their Relational Functions
2015-13: Gerdientje Danner: Psychological Availability. How work experiences spill over into daily family interactions
2015-14: Hannah U. Nohlen: Solving ambivalence in context. The experience and resolution of attitudinal ambivalence