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.
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(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. Stimuli are rarely interpreted outside of context; a negative affective response to ambivalence should thus be dependent on whether the ambivalent evaluations are inconsistent in the current situation.

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**

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\(^6\) 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 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

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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 (\(M = -0.22 \mu V, SE = 0.10 \mu V\), \(p = .006, 95\% CI\) 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, \(p = .028, 95\% CI\) for the difference \([-0.47, -0.03]\). Further supporting this idea, we found that the zygomaticus response to ambivalent stimuli did not differ

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\(^{8}\) \((P + N)/2 - |P - N|\)
significantly from the response to positive stimuli, \( p = ns \), 95% 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, \( F(1.68,147.44) = 7.51, p =.002, \eta^2 = .08 \) (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 (\( M = -0.41 \mu V, SE = 0.17 \mu V \)), \( p = .003 \), 95% 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 (\( M = -0.22 \mu V, SE = 0.13 \mu V \)) was similar to the response to positive stimuli, \( p = ns \), 95% CI for the difference [-0.59, 0.21], but was significantly weaker than towards negative stimuli, \( p = .002 \), 95% 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 (\( \mu V \)) 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, lazy⁹) 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, $F(1.76,160.25) = 3.37, p = .04, n^2 = .04$. 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, $F < 1, p = ns$. 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](image)

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

**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.

\textbf{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 superciliis 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

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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.