



Components of Emotional Meaning: A sourcebook

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CHAPTER

16 Reviving a forgotten dimension—potency in affective neuroscience

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Abstract

The present chapter first provides a review of established theoretical accounts and neuroscientific studies on the processing of emotional stimuli that focus on two dimensions of emotion: valence and arousal. A third dimension, namely potency (or control), had been introduced already in the early work by Osgood and co-workers but ignored in most of current theoretical and empirical work in affective neuroscience. Results of a re-analysis of event-related potential (ERP) data from lexical decision tasks on emotional and neutral German words indicate the potency dimension to play a major role in the elicitation of two distinguishable ERP components that have been previously related to emotional arousal and valence, respectively. Implications for future studies in this field of research are discussed.

Keywords: [dimensions of emotion](#), [valence](#), [arousal](#), [potency \(control\)](#), [event-related potentials \(ERPs\)](#), [early posterior negativity \(EPN\)](#), [late positive complex \(LPC\)](#)

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16.1 Introduction

Most of the recent studies in the field of affective neuroscience, investigating the differences in processing of emotional compared with non-emotion (neutral) stimuli, relate to the assumption that emotional concepts have a dimensional structure. In this context, two aspects become obvious. First, even though the assumption of a dimensional affective space was initially suggested on the basis of linguistic analysis (e.g., Osgood, Suci, & Tannenbaum, 1957), most of emotion research focused on biologically determined domains such as affective pictures or facially expressed emotions. Only recently, the question of how emotional words are processed and about their underlying (neural) mechanisms has been addressed. Second, even though early work on the dimensions that constitute the affective space revealed a three-dimensional structure, the majority of recent studies in this field considered only differences in VALENCE and AROUSAL when contrasting processing differences between emotional and neutral stimuli of different domains. In contrast, the potency² dimension was not taken into account, neither in studies on neural correlates on or peripheral changes to emotion processing.

In this chapter, first I will briefly introduce the most dominant dimensional models of emotion (see also Chapter 2) that have evidently influenced the neuroscientific study of emotion processing. Major findings of this line of research will be briefly reviewed in the following, focusing on studies on electrophysiological and peripheral correlates of emotional VALENCE and AROUSAL. Motivated by both the core findings of the GRID study and some early investigations of event-related brain potentials (ERPs) in response to the three dimensions as suggested by Osgood's work (e.g., Osgood, 1964), a re-analysis of originally VALENCE/AROUSAL-related ERP data in terms of potency differences will be reported. The findings clearly suggest a significant contribution of the potency dimension to emotion-related ERP components that have consistently been related to differences in emotional VALENCE and thus to generally enhanced AROUSAL. Against this background, the chapter will conclude with assumptions for future research on emotional processing, particularly, in the verbal domain.

16.2 A brief outline of dimensional models of emotion

p. 262

Dimensional models have a long history in psychology. Based on introspection and early experimental work, already Wundt (1896) suggested that all affective states can be described by their specific position in a three-dimensional space, depending on their qualities: pleasant/unpleasant, arousing/subduing, and strained/relaxed.

Osgood, Suci, and Tannenbaum (1957) provided the first systematic study, which revealed that the connotative (or emotional) meaning of any verbal term can be described on three dimensions. These dimensions are marked by polar adjectives and together form the so-called "Semantic Differential". The first dimension was named "evaluation" which in general corresponds to the VALENCE dimension in current dimensional models (e.g., Russell, 1980; Lang & Bradley, 2010). The "evaluation" dimension of the Semantic Differential is presented by adjective pairs like fair–unfair, good–bad, pleasant–unpleasant, nice–awful. The second dimension was called "potency" and is characterized by pairs of adjectives like small–large, light–heavy, weak–strong. This dimension is strongly related to dimensions reported by others as "dominance–submissiveness" (Russell & Mehrabian, 1977), "control" (Averill, 1975), or "potency–control" obtained in the GRID study (cf. Fontaine, Scherer, Roesch, & Ellsworth, 2007). The third dimension of Osgood's Semantic Differential is called "activity" and characterized by pairs of adjectives as slow–fast, passive–active, dull–sharp. Similar as for the other two dimensions, "activity" might be directly linked to the AROUSAL dimension in most of current models (but see Ertel, 1964 for a critical discussion of a synonymous use of activity and AROUSAL).

The most dominant dimensional models of emotion that strongly impacted neuroscientific studies on the processing of emotional stimuli—such as affective pictures, emotional facial expressions, and emotional words

—within the last three decades have been Russell’s “Circumplex Model of Affect” (Russell, 1980) and the motivational model by Lang, Bradley, and co-workers (e.g., Lang & Bradley, 2010, see also Hamm, Schupp, & Weike, 2003). Both models suppose that emotions arise from two fundamental systems, one related to hedonic VALENCE (pleasure–displeasure continuum) and the other to AROUSAL, and, further, that each emotion can be understood as a linear combination of these two dimensions, or as varying degrees of both VALENCE and AROUSAL. Interestingly, both accounts differ in their assumption regarding the dependence of the two dimensions. While in Russell’s work both dimensions are seen as independent systems, Lang and colleagues assume a strong dependence between VALENCE and AROUSAL. Within his framework, Russell (1980) proposed that emotions are arranged in a circular structure in which attributes (1) correlate highly with those attributes nearby on the circumference of the circle, (2) correlate near zero with those attributes one quarter way, and (3) correlate inversely with those attributes directly opposite the circle (for a review, see Larsen & Diener, 1992). Affects will always fall between the two axes drawn through the two-dimensional (pleasantness and AROUSAL) space. Per definition, very high or very low values at the pleasantness dimension are accompanied by low values at the AROUSAL/activation dimension and vice versa.

In the second and possibly most influential model in the field of affective neurosciences, both dimensions are seen as reflecting motivational activation (e.g., Lang & Bradley, 2010). Here, affective VALENCE is defined as determined by the dominant of two motive systems in the brain: the appetitive system and the defensive system. Whereas the appetitive system is seen to be primarily activated in contexts that promote survival and to produce positive affect, the defensive system would be activated in contexts that involve threat and prompts negative affect. Both systems are suggested to be implemented by neural circuits in the brain. Their activation provides the source of experienced emotions and triggers several functions in the service of adaptive behavior, such as enhanced sensory attention, organismic mobilization and motor action. Affective AROUSAL is not seen as having a separate substrate but is thought to reflect the intensity of motivational activation (e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001), that is, the specific degree of activation of either the appetitive or the aversive system (Lang, Bradley, & Cuthbert, 1998).

The strong relationship between affective VALENCE and AROUSAL has been shown in several rating studies that revealed a boomerang-shaped distribution of the “affective space” formed by covarying VALENCE and AROUSAL judgments. That is, for affective pictures (Lang, Bradley, & Cuthbert, 1998), words (Bradley & Lang, 1999), and tones (Bradley, Cuthbert, & Lang, 1998), emotionally highly valenced stimuli, being either very negative or very positive, also tend to be highly arousing, whereas stimuli of intermediate (neutral) VALENCE tend to be low in AROUSAL. According to Lang and co-workers, the obtained two “arms” within the affective space reflect the bi-motivational foundation of affective judgments due to the degree to which stimuli engage one of the motivational systems in the brain.

Despite the differences in their basic assumptions concerning the structure of the affective space, both the circumplex model and the motivational model of emotions are consistent in the proposal of two affective dimensions being sufficient to describe emotions. One might wonder about the neglect of a third dimension in consideration of the historical development of dimensional emotion models and, particularly, several pieces of evidence that underscore the relevance of at least one additional dimension building the affective space. Lang and associates directly link their two-dimensional model to the early work of Osgood et al. (1957), but do not even mention the third dimension, that is potency or dominance, of the Semantic Differential (e.g., Lang et al., 1998, pp. 1248–9; Lang & Bradley, 2010, pp. 437–8). This becomes especially surprising since the huge database of normative ratings for the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) does not only provide rating values for affective VALENCE and AROUSAL but also on a third dimension, which is called dominance. The IAPS was developed to provide a set of normative emotional stimuli for studies of emotion and attention and is, in fact, one of the databases most frequently used, particularly, in neuroscientific studies of emotion processing. Applying the so-called Self-Assessment Manikin (SAM; Bradley & Lang, 1994; Lang, 1980) for dominance, participants had to judge each picture on a dimension of “controlled vs in-control”,

ranging from “feelings characterized as completely controlled, influenced, cared for, awed, submissive, guided” to “completely controlling, influential, in control, dominant, autonomous” (Lang et al., 2005, p. 5). Values of these dominance ratings are reported in the IAPS manual and also in the context of some studies (e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley, Codispoti, Sabatenelli, & Lang, 2001). However, they were neither taken into account in the discussion of central findings nor in the theoretical considerations by these authors.

In contrast, Russell (1980) mentioned evidence for at least one additional dimension beside pleasantness/VALENCE and AROUSAL/activation, but strongly argues to skip the potency dimension from his model because of the small proportions of variance they account for or inconsistencies in their interpretations, respectively. However, there is evidence from several studies showing (1) that similarities and differences of emotional qualities cannot sufficiently be explained by a two-dimensional structure (e.g., Osgood, 1966; Russell & Mehrabian, 1977; Morgan & Heise, 1988; Gehm & Scherer, 1988) and (2) that the potency/dominance dimension explains more variance as compared to the AROUSAL dimension as, for instance, provided by the GRID study (cf., Fontaine et al., 2007), but also by some earlier work in the tradition of Osgood (e.g., Ertel, 1964; Osgood, May, & Miron, 1975; Shaver, Schwartz, Kirson, & O'Connor, 1987; Traxel, 1962; Traxel & Heide, 1961). Furthermore, ignoring a construct because of its inconsistent definitions would have seriously hampered past attempts at understanding human behavior, cognition, and affect, ↵ in general. Nevertheless, in the majority of studies investigating the neural mechanism underlying emotional processing and their peripheral correlates only the two affective dimensions—VALENCE and AROUSAL—were incorporated, as will be shortly reviewed in the following sections.

p. 264

16.3 Effects of emotional VALENCE and AROUSAL on peripheral indicators

Even from a lay perspective, no one would doubt that emotions are accompanied by complex, more or less consciously noticeable changes in the body. From a theoretical perspective, there is still no consensus about the nature and differentiation of somatic and autonomous activation patterns accompanying emotional processing or experience. However, there is copious evidence for specific psychophysiological responses such as muscular, cardiovascular, electrodermal, gastrointestinal, or pupillometric activity in the context of emotional processing or affective behavior (for an overview, see Cacioppo, Tassinary, & Berntson, 2000; cf. Kreibitz, 2010, for a review). In line with the framework of Lang and colleagues (e.g., Lang & Bradley, 2010), these peripheral components of emotion are assumed to reflect the preparedness of the body for action (Hamm, Schupp, & Weike, 2003). The preparatory function of emotion involves general AROUSAL, which triggers the whole organism for an action and VALENCE-dependent AROUSAL in service of adaptively specific behavior (e.g., approach or avoidance). A variety of studies using standardized emotional stimuli, such as provided by the IAPS, have shown that normative ratings on the AROUSAL and VALENCE dimensions reliably covary with psychophysiological measures.

For instance, facial muscle activity, as measured by electromyography (EMG), is strongly related to emotional VALENCE ratings. Thus, EMG activity of the corrugator muscle increases linearly as stimuli are rated as more unpleasant; conversely, zygomatic EMG increases with judged pleasantness (Lang et al., 1998; Lang, Greenwald, Bradley, & Hamm, 1993). These activation patterns have not only been shown for affective pictures (Bradley, Codispoti, Cuthbert, & Lang, 2001; Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000), but also for emotional words and tones (e.g., Larsen, Norris, & Cacioppo, 2003).

Electrodermal and cardiovascular activity, and changes of the pupil size are probably the most prominent indicators for enhanced emotional AROUSAL. However, like facial EMG measures neither indicator discriminates between positive and negative hedonic VALENCE. In several studies, both unpleasant and pleasant pictures elicited greater skin conductance responses than neutral pictures (e.g., Bernat, Patrick, Benning, & Tellegen,

2006). Recently, Bradley and associates (Bradley, Miccoli, Excrig, & Lang, 2008) replicated these findings showing larger skin conductance responses to high-arousing affective pictures, regardless of their specific VALENCE. In addition, they measured pupillometric responses which covaried with skin conductance responses. Although the pupil is innervated by both branches of the autonomous nervous system—the parasympathetic and the sympathetic part—this data supports the hypothesis that dilations of the pupil reflect enhanced sympathetic activity (Bradley et al., 2008; see further Critchley, Tang, Glaser, Butterworth, & Dolan, 2005).

Like the pupillary system, the heart is dually innervated by both parasympathetic and sympathetic parts of the autonomous nervous system. Changes in heart rate responses to affective pictures appear with a triphasic pattern of initial deceleration, subsequent acceleration, and secondary deceleration (Hamm et al., 2003). The first phase appears to reflect an effect of enhanced AROUSAL, as both pleasant and unpleasant elicit greater initial cardiac deceleration. Consecutively, the heart rate waveform clearly differed between both valences, as the initial deceleration sustained to unpleasant but change to relative acceleration to pleasant pictures (e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley et al., 2008).

p. 265 All the studies mentioned above measured autonomous or skeletomuscular changes in response to affective pictures. In contrast, the impact of emotional aspects in words on these peripheral systems appears to be smaller (Larsen et al., 2003) or even absent (Bayer, Sommer, & Schacht, 2011) as compared to affective pictures. This is probably caused by the fact that reading words requires the translation of arbitrary symbols and thus provides a less direct source of emotional meaning. Interestingly, recent studies using ERPs provide evidence for a rapid activation of emotional content during word processing, even if the emotional content is not in the focus of attention, leading to similar effects at the level of the central nervous system as has been shown for emotional pictorial stimuli.

16.4 VALENCE, AROUSAL, and potency in the brain—evidence from event-related potentials

The processing of emotional stimuli has also been studied with ERPs, where emotion effects have been shown as early as 100 ms post-stimulus (Junghöfer, Bradley, Elbert, & Lang, 2001; Smith, Cacciopo, Larsen, & Chartrand, 2003; Smith et al., 2006). Initially, ERP studies focused on affective picture processing, but recently the focus has been broadened to the processing of emotional words. Two emotion-related ERP components, distinguished by their time course and distribution over the scalp surface, have been suggested to reflect distinct stages of emotion processing: the early posterior negativity (EPN; Junghöfer, Bradley, Elbert, & Lang, 2001; Schupp, Hamm, & Weike, 2003) and the late positive complex (LPC; e.g., Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Schupp et al., 2000).

The EPN consists in an early difference wave with negative polarity at temporo-occipital electrode sites around 200 and 320 ms, in response to both positive and negative compared to neutral pictures (e.g., Schupp et al., 2004). On the basis of its similarity in latency and scalp distribution to ERP components elicited by voluntary orientation of attention to non-emotional, the EPN is suggested to result from reflex-like visual attention, facilitating sensory encoding processes, and to reflect a transitory phase in which task-relevant stimuli are selected for further, more elaborate processing (see Potts & Tucker, 2001). Recent studies have also shown EPN effects to emotional words (e.g., Herbert, Kissler, Junghöfer, Peyk, & Rockstroh, 2006; Kissler et al., 2007; Schacht & Sommer, 2009a, 2009b). The EPN to words is highly similar to the EPN elicited by affective pictures and emotional facial expressions, indicating at least partially shared or overlapping brain systems involved during this early stage of emotion processing, even though it appears at longer latencies (Schacht & Sommer, 2009a). In a series of experiments (Palazova, Mantwill, Sommer, & Schacht, 2011; Schacht & Sommer, 2009a, 2009b), we have consistently shown that the EPN to emotional words coincides with or follows ERP

components that reflect lexical access, indicating that the emotional connotation of written words is part of their semantics.

Sustained elaborate processing of emotional stimuli is presumably reflected in augmented amplitudes of the LPC, which have been shown for affective pictures of both positive and negative VALENCE (e.g., Cuthbert et al., 2000; Schupp et al., 2000; Schupp et al., 2004), as well as for emotional words (e.g., Herbert et al., 2008; Naumann et al., 1992; Schacht & Sommer, 2009a, 2009b). The LPC typically develops in the time range of the P300 component—that is, around 300 ms—and lasts for several hundred milliseconds. The P300 to non-emotional stimuli increases when the eliciting stimulus is attended (e.g., Johnson, 1988), infrequent, or task relevant (e.g., Picton & Hillyard, 1988), and therefore, presumably reflects processes of stimulus evaluation and memory updating (for reviews, see Bashore & van der Molen, 1991; Polich, 2007). Given that processes similar to those in the P300 are reflected in the LPC, it has been suggested that increased LPCs to emotional stimuli are caused by continued perceptual and elaborate analysis that are initiated by their higher intrinsic relevance.

Since the effect of positive emotional VALENCE on both the EPN and LPC amplitudes is similar, this effect is interpreted as being due to the emotional stimuli's larger AROUSAL value (Hamm et al., 2003; Kayser et al., 1997; Schupp et al., 2000). For the LPC, this interpretation has been challenged by studies showing LPC effects of VALENCE, although the AROUSAL level of stimuli had been controlled for pictures (Conroy & Polich, 2007; Yuan et al., 2007) and words (Bayer, Sommer, & Schacht, 2010). In addition, a number of studies reported differing ERP modulations for positive and negative pictures (Delplanque, Silvert, Hot, & Sequeira, 2005; Delplanque, Silvert, Hot, Rigoulot, & Sequeira, 2006; Ito, Larsen, Smith, & Cacioppo, 1998) and words (Herbert et al., 2008). These results do not support an equivocal conclusion about the influences of emotion on LPC amplitudes, but suggest a more complex modulation than by mere variations of AROUSAL.

Moreover, a few studies on emotional word processing indicate that not only the LPC but also the EPN reflect more than pure effects of enhanced general AROUSAL. For instance, Schacht and Sommer (2009a) reported EPN effects for positive but not negative German verbs in a lexical decision although the latter revealed higher AROUSAL ratings. This finding was recently replicated by Palazova et al. (2011), showing larger EPN effects to positive verbs and adjectives as compared to negative words under same task demands.

Evidence for potency effects on ERPs in emotional word processing is scant. Only a few, particularly early studies, implemented the three dimensions of Osgood's (1964) Semantic Differential—evaluation, potency, and activation—in their investigations of ERP correlates of word processing. For instance, Chapman, McCrary, Chapman, and Martin (1980) recorded ERPs while participants loudly repeated words or judged their semantic meanings on rating scales that predominantly loaded on one of the three semantic dimensions. Based on classification functions, the authors report ERPs to reflect differences between the three dimensions as well as between high and low rating values along each dimension. However, since in this study, only recordings from three midline electrodes are reported, a comparison to more recently reported ERP effects to emotional VALENCE and AROUSAL, is impossible. A more differentiated picture about the influence of Osgood's dimensions on ERPs to single words is provided by two studies by Skrandies (Skrandies, 1998; Skrandies & Chiu, 2003). In the first study (Skrandies, 1998), participants were presented with German single words, which significantly differed on one of the three semantic dimensions and had to be visualized and memorized for subsequent recognitions. Here, three parameters of ERP components—latency, amplitude strength, and distribution over the scalp surface—were analysed according to words classified as high or low on the dimensions. Findings indicate influences of all dimensions on several ERP components in these ERP parameters. For instance, differences on the potency and the evaluation (i.e., VALENCE) dimension prolonged the latency of the visually evoked P 100 component in comparison to differences on the activation (AROUSAL) dimension. In the time range of the EPN (around 220 ms), a component of enhanced posterior negativity appeared with significantly shorter latency for stimuli differing on the potency dimension as compared to stimuli differing on the other two dimensions. This finding indicates that the EPN—which in most recent studies has been strongly related

to AROUSAL—might also be sensitive to differences at the potency dimension. In contrast, the amplitudes of this posterior negativity did not differ between the word classes, that is differences on each of the dimensions. More evidence for such early effects of these semantic dimensions has been provided by a study using Chinese two-character words with comparable task demands (Skrandies & Chiu, 2003). Results show differences in the above-mentioned parameters of, particularly, early ERP components elicited by differences on the three dimensions. However, both studies revealed somewhat contradictory findings when looking at their results in detail. Therefore, a clear conclusion beyond the specific impact of not only emotional VALENCE and AROUSAL, but also of potency on visual word recognition, as reflected in ERPs, can not be drawn. Further, a direct comparison to more recent studies on emotional word processing can only be made indirectly because of several differences in ERP recordings and analyses. In the following, I will try to provide a first approach to bridge this gap.

16.5 Potency in emotional word processing—a first approach

In a recent study, Palazova and co-workers (Palazova et al., 2011) investigated the functional locus of emotion effects in the processing of single emotional words. Participants performed lexical decisions on emotionally positive, negative, and neutral German nouns, verbs, and adjectives while ERPs from 61 electrode sites were recorded. In line with previous studies (e.g., Schacht & Sommer, 2009a, 2009b), emotional words elicited an EPN and enhanced amplitudes of the LPC. Interestingly, these effects were more pronounced for emotionally positive adjectives and verbs as compared to negative words, even though emotionally positive words were judged as less arousing in pre-experimental ratings. As in the majority of recent studies in this field, the selected emotional words used in this study were not controlled for potency. Motivated by the main findings of the GRID study, showing that emotion terms differ not only on the VALENCE and AROUSAL but also on the potency and expectancy dimensions, a re-analysis of the original ERP data was performed in order to get first answers to the following questions. (1) Is there an impact of potency on the processing of *emotional* words? (2) Do differences on the potency dimension contribute to standard ERP components, that is, EPN and LPC, which have consistently been related to differences in emotional VALENCE and AROUSAL? (3) Are there other or additional ERP effects, respectively, of potency and if so, when in time do they appear during word processing?

In a first step, a subset of emotional words from Palazova et al. (2011) was selected, consisting of 103 word stimuli for which potency ratings were available in the literature. These rating values were taken from a database provided by Schwibbe, Räder, Schwibbe, Borchardt, and Geiken-Pophanken (1992) containing judgments of VALENCE, AROUSAL, and potency for single German verbs, adjectives, and nouns. Judgments of VALENCE and AROUSAL were comparable between the database by Schwibbe et al. (1992) and the study by Palazova et al. (2011) $r = 0.975$ and $r = 0.807$, $ps < 0.001$. Examples for selected words are *schwach* (weak), *faul* (lazy), *leiden* (to suffer), which revealed low potency ratings, and *erfolgreich* (successful), *stark* (strong), *zwingen* (to constrain), which revealed high potency ratings. Interestingly, emotionally negative words ranged from low to high potency ratings, whereas emotionally positive words were mostly characterized by high potency ratings, reflected in a positive correlation between VALENCE and potency ratings, $r = 0.325$, $p < 0.01$ (see Figure 16.1a for the distribution of selected words on the dimensions of VALENCE and potency).

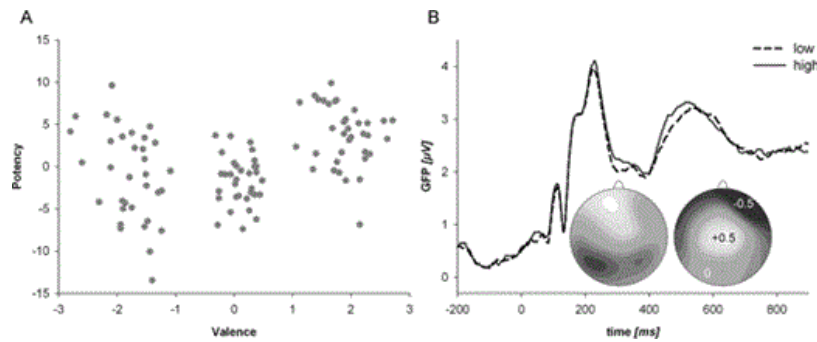


Figure 16.1 **a** Distribution of ratings on the potency (Schwibbe et al., 1992) and VALENCE (Palazova et al., 2011) dimensions. **b** Global field POWER (GFP) of ERPs to words of high versus low potency. Significant differences were obtained between 250 and 350 ms and 400 and 550 ms. Embedded maps depict the scalp distributions of ERP differences between words of high minus low potency within these time intervals.

In a next step, ERPs to the selected subset of emotional words from Palazova et al. (2011) were analysed in several ways³. First, ERP mean amplitudes were re-calculated item-wise across participants, allowing a classification according to their potency values, and segmented into consecutive 50 ms time windows after stimulus onset. Figure 16.1b depicts the global field POWER (GFP; Lehmann & Skrandies, 1980) of grand averaged ERPs, contrasted for words of high versus low potency as defined by median split. GFP reflects the overall ERP activity across all single electrodes over the scalp at any given moment and thus a measure of amplitude strength. As can be seen in Figure 16.1b, words of high potency elicited larger GFP amplitudes at two different processing stages: around 300 ms and between 400 and 550 ms. This impression was verified by overall ANOVAs on mean ERP amplitudes, including the factors electrode (61) and potency (2), that revealed significant interactions⁴ between these factors in the time windows between 250 and 350 ms, $F_s(60,1140) > 3.1$, $ps < 0.01$, $\eta_p^2 > .140$, and between 400 and 550 ms, $F_s(60,1140) > 2.8$, $ps < 0.01$, $\eta_p^2 > .127$. Importantly, the scalp distributions of these potency effects (see Figure 16.1b) clearly resemble the distributions of the EPN and LPC components as shown for positive and negative words in previous studies (e.g., Schacht & Sommer, 2009a, 2009b), and particularly, for emotionally positive words when ERPs were classified for emotional VALENCE in the original analyses by Palazova et al. (2011) and appeared in the same time windows. No further effects of potency were found within the other time segments.

Since the distribution of potency values differs within each of the three VALENCE categories (positive, negative, neutral; see Figure 16.1a), additional ANOVAs on mean ERPs were conducted, including the factors electrode (61), potency (2—high, low), and VALENCE (3—positive, negative, neutral). Here, potency values were divided into two bins for each VALENCE category separately. An additional selection of the word material was made, in order to control for non-emotional, linguistic factors. Finally, 15 words per potency by VALENCE condition contributed to the data analyses, which did not differ in terms of word length (number of letters, number of syllables), word frequency, and imageability ratings between the conditions. ANOVAs revealed significant potency by electrode interactions within the time window of the EPN, between 250 and 350 ms, $F_s(60,1140) > 2.8$, $ps < 0.05$, $\eta_p^2 > 0.126$, but no effects of VALENCE appeared. In contrast, between 400 and 550 ms (LPC), both potency and VALENCE significantly affected ERP amplitudes, $F_s(60,1140) > 3.0$, $ps < 0.01$, $\eta_p^2 > 0.140$, whereas no interaction between these two factors appeared. Also in these analyses, no further effects of potency or VALENCE, respectively, have been obtained in other time windows.

Despite the constraints raised by such re-analyses as realized here, the present data indicate that potency actually contributes to ERP effects in emotional word processing. Importantly, these effects appear with both similar latencies and scalp topographies as ERP components that have been previously related to enhanced AROUSAL or positive and negative VALENCE, respectively.

16.6 Conclusions

Words definitely provide a special origin of emotion. For instance, they help humans to label and communicate their emotional states and thus play a crucial role in social interactions. From another perspective, many texts elicit emotions in readers since they provide descriptions of emotional situations or states of figures and are appreciated for pleasure or excitement given in the reader. Whereas a lot of research aimed to investigate the mechanisms underlying the preferential processing of emotional stimuli such as affective pictures or emotional facial expressions, the study of processing emotion words and emotional words, respectively, has just recently received more attention. Most of the studies on emotional word or affective picture processing measured behavioral, peripheral, and electrophysiological responses to stimuli that maximally varied on the VALENCE and the AROUSAL dimension, that is, responses to high-arousing positive or negative compared to low-arousing neutral stimuli, presumably, since they have been more or less directly linked to the two-factor model suggested by Lang and colleagues (e.g., Lang & Bradley, 2010). Despite a few studies, the potency dimension had not been taken into account, even though it was considered as a highly relevant dimension of affective space in the pioneering work in this area (e.g., Osgood, 1964).

In the present chapter, a re-analysis of ERP data is provided that aimed to shed light on the question whether and how potency differences might contribute to emotion-related ERP effects. In fact, when ERPs to emotional words differing in their potency values were contrasted, two well-known ERP components were obtained with larger amplitudes to words with high, as compared to words with low, potency ratings. Both components, the EPN and the LPC, have previously been related to the AROUSAL dimension (e.g., Schupp et al., 2007), although there is evidence for VALENCE-specific effects, particularly, in emotional word processing (e.g., Herbert et al., 2008; Schacht & Sommer, 2009a; Palazova et al., 2011). Interestingly, these studies reported some kind of “positivity bias”, that is, a larger effect of positive than negative VALENCE on the EPN and/or LPC components, which has also been reflected in facilitated processing of positive words. Given the fact that positive words are characterized also by high potency values, one might speculate whether this processing advantage of positive words is—at least to some extent—derived from potency effects. In contrast, the selected emotionally negative words varied across the whole potency dimension, indicating a larger diversity of emotional meanings within unpleasant concepts. This is, in my opinion, at variance with the assumption that all kind of negative stimuli might activate one unitary motivation system as suggested by Lang and co-workers (e.g., Lang & Bradley, 2010). Future research is needed to differentiate between different sub-types of negative VALENCE and to specify their potentially varying effects in emotion processing.

p. 270 The present data do not only support the idea that more than two dimensions constitute the semantic space of *emotion terms*, as proved by the GRID study. Moreover, it extends this assumption to the processing of *emotional words*. Recently, Pavlenko (2008) proposed the necessity for such differentiation between linguistic concepts based on differences in their functions: emotion words (equivalent to *emotion terms* used here) are words that directly refer to particular affective states or processes (e.g., “happy,” “to rage”); emotion-laden words (equivalent to *emotional words* used here) do not directly refer to emotions, but instead express or elicit emotions from the “interlocutors” (e.g., “loser,” “cancers”). Thus, emotion words have the specific function to directly describe (“he/she is sad”) or express emotions (“I feel sad”), which is not the case for emotional words. Pavlenko further suggests excluding “emotion-related” words, that describe behavior related to particular emotions but not naming the actual emotions themselves (“tears” and “to scream”) from the category of emotion words. Within emotion-laden words, there are different subcategories, which are unclearly demarcated, since words may cross or overlap the subcategories or receive or change emotional connotations in some contexts. As yet, all studies on ERP correlates of emotion effects in language, intermix these different types of words, ignoring potential differences in their semantic representation.

A last remark concerns the most important dimension of emotional meaning: emotional VALENCE. While dimensional models as introduced in this chapter consider emotional VALENCE as a pleasantness dimension, it

has been suggested to differentiate between different types of valences (Scherer, 2010a). In his approach, Scherer assumes the existence of different types of VALENCE and that their involvement is defined by the specific type of the appraisal criterion (stimulus evaluation check, SEC). Based on the major classes of SECs, four types of VALENCE criteria are assumed: VALENCE as pleasure (intrinsic pleasantness), VALENCE as satisfaction (goal/need conduciveness), VALENCE as self-worthiness (compatibility with self-standards), and VALENCE as moral worthiness (compatibility with norms/moral standards). One might assume that these different types of VALENCE, which apparently differ in their complexity, might be reflected in ERP components distinguishable in their time course. While early ERP components, as for instance, the EPN might indeed reflect differences in intrinsic pleasantness, components appearing with longer latencies, as for instance, the LPC, might reflect VALENCE differences that are involved in more complex SECs as compatibility with moral standards.

To sum up, in the present chapter, a first attempt was made to investigate the contribution of potency on emotion-related ERP components, which usually are suggested to reflect emotional VALENCE and/or AROUSAL. A re-analyses of ERP data from a study of Palazova and co-workers (Palazova et al., 2011) indeed revealed significant potency effects on both the EPN and the LPC component. Future research should take this second-most important dimension of emotional meaning into account and aim to specify the interplay between potency, AROUSAL, and VALENCE and its impact on language processing. In addition, a specification of linguistic differences between emotion terms and emotional words and their subcategories may help to understand the structure of the human semantic system.

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Notes

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- 2 The dimension referred to as potency in this chapter generally corresponds to the POWER dimension identified in the GRID study.
- 3 In the original study, ERPs were recorded from 20 university students while performing lexical decisions on correct German words and—randomly intermixed—pseudowords. All stimuli were presented in black letters on a dark-gray background until button press.
- 4 Please note that ERPs were offline transformed to average reference. By definition, the average reference sets the mean amplitude across electrodes to zero for each condition. Therefore, in ANOVAs including all electrodes, only interactions with the electrode site are meaningful. To adjust the degrees of freedom of the *F*-ratios for violations of the sphericity assumption, the Huynh-Feldt correction was applied. Corrected *p*-values and uncorrected degrees of freedom values are reported.