The Functional Locus of Emotion Effects in Visual Word Processing

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Abstract

Emotional valence of words influences their cognitive processing. The functional locus of emotion effects in the stream of visual word processing is still elusive, although it is an issue of great importance for the disciplines of psycholinguistics and neuroscience. In the present dissertation event-related potentials (ERPs) were applied to examine whether emotional valence influences visual word processing on either lexical or semantic processing stages. Previous studies argued for a post-lexical locus of emotion effects, whereas a lexical locus has been indicated by a few heterogeneous findings of very early emotion effects. Three emotion-related ERP components were observed that showed distinct temporal and topographic distributions, and thus seem to reflect different processing stages in word recognition. Results are discussed within a framework of common assumptions from word recognition and semantic representation models. As a main finding, emotion impacted most strongly semantic processing stages. Thus, emotional valence can be considered to be a part of the meaning of words. However, an interaction of emotion with a lexical factor and very early emotion effects argued for an additional functional locus on lexical, or even on perceptual processing stages in word recognition. In conclusion, emotion impacted visual word processing on multiple stages, whereas distinct emotion-related ERP components, that are subject to different boundary conditions, were associated each with an early (pre-)lexical locus or a late semantic locus. The findings are in line with models of visual word processing that assume time-flexible and interactive processing stages, and point out the need for integration of word recognition models with models of semantic representation.

Keywords: emotion, word processing, event-related potentials, early posterior negativity

Zusammenfassung

Die emotionale Valenz von Wörtern beeinflusst deren kognitive Verarbeitung. Ungeklärt ist, obwohl von zentraler Bedeutung für die Disziplinen der Psycholinguistik und der Neurowissenschaften, die Frage nach dem funktionellen Lokus von Emotionseffekten in der visuellen Wortverarbeitung. In der vorliegenden Dissertation wurde mit Hilfe von Ereignis-korrelierten Potentialen (EKPs) untersucht, ob emotionale Valenz auf lexikalischen oder auf semantischen Wortverarbeitungsstufen wirksam wird. Vorausgegangene Studien weisen auf einen post-lexikalischen Lokus von Emotionseffekten hin, wobei einige wenige heterogene Befunde von sehr frühen Emotionseffekten auch einen lexikalischen Lokus vermuten lassen. In der vorliegenden Arbeit wurden drei emotions-sensitive EKP Komponenten beobachtet, die distinkte zeitliche und räumliche Verteilungen aufwiesen, und daher verschiedene Wortverarbeitungsstufen zu reflektieren scheinen. Die Ergebnisse wurden im Rahmen von allgemeinen Annahmen aktueller Wortverarbeitungs- und semantischer Repräsentationsmodelle diskutiert. Als zentrales Ergebnis kann benannt werden, dass Emotion am stärksten semantische Wortverarbeitungsstufen beeinflusste. Hieraus wurde geschlussfolgert, dass emotionale Valenz einen Teil der Wortbedeutung darstellt. Eine Interaktion mit einem lexikalischen Faktor sowie sehr frühe Emotionseffekte deuten auf einen zusätzlichen Lokus auf lexikalischen oder sogar perzeptuellen Wortverarbeitungsstufen hin. Dies bedeutet, Emotion veränderte die visuelle Wortverarbeitung auf multiplen Stufen, dabei konnten separate emotions-sensitive EKP Komponenten, die unterschiedlichen Randbedingungen unterliegen, mit jeweils einem frühen (pre-)lexikalischen und einem späten semantischen Lokus in der Wortverarbeitung in Verbindung gesetzt werden. Die Befunde stützen Wortverarbeitungsmodelle, die zeitlich flexible und interaktive Wortverarbeitungsstufen annehmen, und unterstreichen die Notwendigkeit der Integration von Wortverarbeitungs- und semantischen Repräsentationsmodellen.

Schlagwörter: Emotion, Wortverarbeitung, Ereignis-korrelierte Potentiale, Early posterior negativity

1. Introduction

Language is the most powerful and complex cognitive ability and the understanding of language will presumably contribute eminently to the understanding of human nature. Language is a relatively young phylogenetic attainment and can be described as a symbolic and arbitrary system used for communication (Harley, 2008). Although reading is a more recent development, humans are nevertheless highly specialised in comprehending written language. Within milliseconds, we recognize letter strings as words, extract meaning from them, and are able to adapt behaviour according to this information. Simple everyday examples of the human expertise in word recognition are reading “mind the gap” sign on the tube or “push” and “pull” signs on doors of public facilities. A picture may say more than thousand words, but in those examples a simple phrase or even a single word possesses detailed information that is exact and specific enough to enable a person to plan and execute a hand movement in order to open a door, without interrupting an ongoing conversation. In the past decades word processing, especially visual word processing, has gained a vast and complex body of research. Most of the word recognition models were developed on the basis of data acquired with concrete neutral words. However, we read on a daily basis words which are emotionally charged, as for example “brilliant” in an advertising, or “rescue” on a charity poster, “riots” sprayed on a building’s wall, or “emergency exit” at the office. Such positive or negative words are exceptionally attention-catching and may therefore impact behaviour; nevertheless, they have gained less research attention to date, especially in the context of reading research.

A preferential processing of emotional stimuli, for instance emotional pictures or facial expressions, compared to neutral ones has been repeatedly shown (e.g., Vuilleumier & Pourtois, 2007). The processing advantage of emotional stimuli has been explained by their high intrinsic relevance to the organism that leads to binding of attention and processing resources (e.g., Lang, 1995). From an evolutionary perspective such mechanisms would allow for fast behavioural adaptation to biologically significant stimuli such as food or danger. Although words are symbolic stimuli which are not evolutionary prepared, a comparison between emotional words and facial expressions showed that similar neural correlates seem to underlie emotion processing in these separate domains (Schacht & Sommer, 2009a). The present work focuses on the verbal domain and aims at a delineation of emotion processing from a psycholinguistic perspective.

The main aim of the present work is to contribute to the question of the functional locus of emotion effects within the stream of visual word processing. This question was assessed by means of a series of experiments applying the event-related potentials (ERPs) and utilizing the high temporal resolution of the method. In three experiments, the following issues were examined: (i) An early locus, (ii) a late locus of emotion effects in visual word processing, and (iii) the automaticity of emotion effects in words. Present results should further help to address open questions of the boundary conditions of emotion effects in words, and how emotional valence is represented considering recent models of word recognition and word meaning.

In the following, a theoretical framework will be outlined by reviewing models and previous findings from visual word and emotion processing. Based on this background, three experiments were designed targeting the question how emotion impacts visual word processing. After recapitulating their main results, a final discussion will integrate the main findings in the current scientific discourse of emotion and word processing.

2. Theoretical and empirical background

2.1. Visual word processing

In the past 40 years of psycholinguistic and neuroscientific research numerous models of word recognition (e.g., Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Forster, 1976, 1979; Grainger & Jacobs, 1996; McClelland & Rumelhart, 1981; Morton, 1969; Norris, 1994; 2006; Plaut, McClelland, Seidenberg, & Patterson, 1996; Rumelhart & McClelland, 1982; Seidenberg & McClelland, 1989) and semantic representation (e.g., Harm & Seidenberg, 2004; McRae, 2004; Murray & Forster, 2004; Plaut & Shallice, 1993; Vigliocco, Vinson, Lewis, & Garrett, 2004) have emerged. Undisputed of denotative differences between models Neumann (1990) described a standard model of word recognition with several common assumptions. According to Neumann, most general assumptions are that word recognition consists in an activation of internal representation(s), and that there are at least two distinct kinds of representations to be accessed: lexical and semantic representations. Thus, almost all models of word recognition assume at least three processing stages when a word is read: (i) after a perceptual analysis (ii) letter strings are recognized as words (sublexical and lexical access), so that (iii) semantics or phonology[1] can be accessed (Rastle, 2007, for a review). Models differ in respect of their assumptions about discreteness and autonomy of the processing stages, as well as the mechanisms of accessing the word's lexical and semantic representations. While some of the early models of visual word recognition postulated discrete and autonomous processing stages (e.g. Forster, 1976) - that is higher level processing like semantic activation was assumed not to affect low level processing - more recent approaches used a computational metaphor to describe the cognitive language system (e.g. Coltheart et al., 2001; Rumelhart & McClelland, 1982) and assumed interactive processing stages organized in a cascaded manner. For a classification and evaluation of visual word recognition models, see also Jacobs and Grainger (1994). Although the semantic system is a constituting part of the visual word recognition models, it is often underestimated because early research concentrated more strongly on lexical representations. Therefore, a separate class of models of the semantic system should be considered. Within the scope of these models, two organizational principles of conceptual structure are broadly accepted: componentiality and similarity, that is, concepts are made of smaller elements of meaning which are organized based on semantic similarity. Most influential are theories that assumed meaning of words to be represented by means of conceptual features (e.g., Allport, 1985; Farah & McClelland, 1991; Jackendoff, 1992; Smith, Shoben, & Rips, 1974; Vigliocco et al., 2004). While early models assumed necessary and sufficient features to define a concept (e.g., Smith et al., 1974), more recent models abandoned this assumption and proposed that concepts might be flexible and depend on context (Barsalou, 1993). Importantly, the opposition of theories of amodal, abstract representation versus theories of embodied features, that is features which are grounded in perception and action (for reviews, please see Moss, Tyler, & Taylor, 2007, and Vigliocco & Vinson, 2007), seems to be resolved in favour of models of flexible concepts which are based on embodied features (for a review, please see Kiefer & Pulvermüller, 2011).

Event-related potentials have been frequently employed to examine the neural correlates of visual word processing because the method allows for a continuous analysis of ongoing cognitive processes from stimulus onset until the response with a fine grained temporal resolution in the range of milliseconds. Three different parameters of ERP components are of particular interest: onset *latency* and *amplitude* differences indicate differences in timing and

[1] Most models also incorporate a word phonology unit. The question whether accessing phonology is possible without accessing meaning has been a main motor for developing the models. Since this point is of no relevance for the research question of this work, it will not be reviewed here.

intensity of processing; *scalp distributions* reveal at least relative localization of the neural substrate involved in processing.

Although the question when exactly the brain extracts different kinds of information from words has been frequently in focus of research, the time course of word recognition is still elusive. Grainger and Holcomb (2009) described a theoretical framework based on results from a masked priming paradigm for the time course of visual word recognition: The authors linked ERP components peaking around 150 ms, 250 ms to 325 ms, and 400 ms relative to word presentation, to visual feature processing, sublexical and lexical activation, and semantic processing, respectively (see also, Holcomb & Grainger, 2006; 2007). Hauk, Davis, Ford, Pulvermüller, and Marslen-Wilson (2006) aimed to delimit the time course of word recognition by employing a lexical decision task (a task in which subjects decide whether a letter string is a correct word or not) and a linear regression analysis on ERPs with the factors word length, letter n-gram frequency, word frequency, and semantic coherence. The latter factor denotes the degree to which morphologically similar words are related to each other. Effects of perceptual (word length) and lexical factors (letter n-gram frequency, word frequency) were found around 100 ms and 110 ms, respectively, and effects of semantic coherence already at about 160 ms after stimulus presentation. In conclusion, brain responses to word's semantic content may start already within 200 ms post stimulus presentation. Two important implications arise from these findings: First, perceptual and lexical processing stages may take place in the time range of the P1 component - a posterior positivity peaking around 100 ms post-stimulus which is associated with processing in visual cortex - which is even earlier than supposed by the masked priming paradigm data. Comparable timings were shown for word length effects (~ 60 ms onset, see Assadollahi & Pulvermüller, 2003; ~ 100 ms onset, see Hauk & Pulvermüller, 2004) and word frequency (~ 150 ms onset, see Hauk & Pulvermüller, 2004; ~ 130 ms onset, see Sereno, Rayner, & Posner, 1998). And second, semantic processing may be underway earlier than the timing of the most prominent semantic-related component, the N400 - a negativity between 200 and 600 ms post-stimulus, which is largest over centro-parietal areas (for reviews, Kutas & Federmeier, 2000; 2011). The N400 has been found to systematically vary with processing of semantic properties, for instance semantic violations (Kutas & Hillyard, 1980), or word concreteness (Kounios & Holcomb, 1994; West & Holcomb, 2000), and has been functionally linked to contextual integration and the ease of semantic knowledge retrieval. In conclusion, the current ERP literature of word recognition suggests stages of perceptual, sublexical and lexical processing, culminating in semantic activation, similarly to the theoretical models. Importantly, results indicate that these processing stages take place in an overlapping and in a time-variable cascaded manner (Barber & Kutas, 2007; Grainger & Holcomb, 2009; Hauk, Coutout,. Holden, & Chen, 2012; Pulvermüller, Shtyrov, & Hauk, 2009). To my knowledge none of the word recognition or semantic representation models incorporates emotion effects. In the following chapter, current ERP literature on affective word processing will thus be reviewed, and it will be discussed how valence could exert its influence on visual word processing within the scope of the outlined theoretical framework.

2.2. Emotion processing in words

There is no doubt that humans are emotional beings and accordingly plenty of theories of emotion exist, which describe and define different affective phenomena (for a review, please see Scherer, 2000). Dimensional models have a long tradition in psychology and are among the most influential theories of affective states and affective processing (Duffy, 1941; Ostgood, Suci, & Tannenbaum, 1957; Plutchik, 1980; Russel, 1980; Wundt, 1905). The motivated attention theory of emotion is a two-dimensional model by Lang and colleagues (Lang, 1995; Lang, Bradley & Cuthbert, 1998; Lang, Greenwald, Bradley & Hamm, 1993) which postulates a first dimension of *valence*, that is, whether a stimulus is experienced in a positive or negative way, and a second dimension of *arousal*, which denotes the intensity of the experience. Two distinct motivational brain systems, which react adaptively to stimuli, underlie these dimensions. The *appetitive* system responds to pleasant, hedonic stimuli signalling a biological advantage; the *defensive* system responds to unpleasant, dangerous signals. Both systems denote the valence dimension, whereas the arousal dimension only represents how strongly the systems are activated. The motivated attention theory is of particular interest in the study of emotion processing in words, so that beyond linguistic factors like word frequency or word length, current word databases also include, valence ratings (e.g., Berlin Affective Word List (BAWL); Vo, Jacobs, & Conrad, 2006, in German) allowing the study of emotion processing with controlled stimulus material.

Already early ERP studies with words showed an influence of emotional valence on brain potentials (Begleiter & Platz, 1969; Chapman, 1979). In the recent literature, two separate emotion-related ERP components with distinct time course and scalp distributions have been repeatedly reported: The *early posterior negativity* (EPN) and the *late positive complex* (LPC). The EPN is observed at latencies of 200 to 350 ms after stimulus presentation and consists in an augmented negativity to emotional stimuli as compared with neutral stimuli at occipito-temporal sites. It was first shown in studies employing emotional pictures (e.g., Junghöfer, Bradley, Elbert, & Lang, 2001; Schupp, Junghöfer, Weike, & Hamm, 2004), and is often interpreted in the scope of the motivated attention theory as a reflection of attention binding by intrinsically relevant stimuli, which facilitates their further processing. The EPN has been replicated numerous times with emotional words (Herbert, Kissler, Junghöfer, Peyk, & Rockstroh, 2006; Kissler, Herbert, Peyk, & Junghöfer, 2007; Schacht & Sommer, 2009a; 2009b), indicating that arbitrary symbolic stimuli such as words, whose emotional connotation is ontogenetically learned, are also salient and draw on attention and processing resources. In line with this, Schacht and Sommer (2009a) compared lexical decisions on emotional words with an integrity decision on emotional facial expressions and demonstrated topographically similar EPNs in a within-subject comparison between evolutionary relevant (faces) and symbolic (words) stimuli. Moreover, the EPN has been found across a variety of tasks: silent reading (Herbert, Junghöfer, & Kissler, 2008; Kissler et al., 2007), lexical decisions (Hinojosa, Mendez-Bertolo, & Pozo, 2010; Schacht & Sommer, 2009b), emotional stroop task (Franken, Gootjes, & van Strien, 2009), grammatical judgement task (Kissler, Herbert, Winkler, & Junghöfer, 2009). In a direct comparison of structural with lexical and semantic decisions, the EPN has been shown independently of the task (Schacht & Sommer, 2009b). In contrast, Hinojosa et al. (2010) showed that a minimum of lexico-semantic activation is needed for an EPN to be elicited by words. Further, EPN has been reported to occur in different word classes: adjectives (Herbert et al., 2008), nouns (Kissler et al., 2007), and verbs (Schacht & Sommer, 2009b), but at variable latencies (200 ms, 200 ms, and 380 ms, respectively). With regard to the functional locus of the EPN in word processing, Kissler et al. (2007) proposed that, based on the latency of EPN, emotion effects take place not on a prelexical, but on a semantic processing stage. Schacht and Sommer (2009b) were the first to provide direct evidence for a locus of emotion on a semantic rather than a (pre-)lexical processing stage by employing the lexical decision task. In this task a lexicality effect (a centro-parietal negativity to pseudowords compared with legal words: Braun et al., 2006; Chwilla, Brown, & Hagoort, 1995) indicates the time point at which at least a lexical representation of the word must have been accessed. In their study with verbs, Schacht and Sommer showed the EPN to appear only after the lexicality effect, which indicated post-lexical processing, so that the authors assumed that emotion effects are based on analysis of the word's meaning.

The second emotion-sensitive ERP component, the LPC, has been observed from latencies of 350 ms onwards, peaking around 500 ms after stimulus presentation. It consists in an increased centro-parietal positivity for emotional stimuli relative to neutral ones, which has often been found in studies with written words in different tasks: silent reading (Herbert et al., 2008), counting grammatical category (Kissler et al., 2009), lexical decision task (Carretie et al., 2008; Hinojosa et al., 2010; Kanske & Kotz, 2007; Schacht & Sommer, 2009b). The LPC develops in the time range of the P300 which is associated with controlled, explicit stimulus evaluation (for a review, please see Polich, 2007) and might reflect similar processes, that is sustained elaborate processing of emotion. In contrast to the EPN, this late emotion-sensitive component has been modulated by tasks demands, in particular, depending on the depth of processing required by the task. The LPC was absent in a structural task (Schacht & Sommer, 2009b), but was enhanced in tasks where words' valence or semantic content were task-relevant (Fischler & Bradley, 2006; Naumann, Bartussek, Diedrich, & Laufer, 1992), which indicates a late functional locus during the semantic processing stage in visual word recognition.

Besides the two emotion-related ERP components EPN and LPC, also *very early emotion effects* (VEEEs) have been observed (e.g., Bernat, Bunce, & Shevrin, 2001; Ortigue et al., 2004). Although VEEEs have been reported inconsistently across tasks, conditions and words' samples, they may be indicative of a very early locus of emotion effects in word recognition. For example, Bernat et al. (2001) showed P1 component modulations to sub- and supraliminally presented affective adjectives. Two recent studies reported ERP main effects of emotion at about 100 ms post-stimulus with the lexical decision task. Scott, O'Donnell, Leuthold, and Sereno (2009) observed a main emotion effect and an interaction with word frequency in the time window of the P1 component (80 ms - 120 ms). Only negative high-frequent words showed lower P1 amplitudes than high-frequent positive and neutral words. Scott and colleagues proposed that, similarly to word frequency, high-arousal may lead to stronger lexical representations of words. At some variance, Hofmann, Kuchinke, Tamm, Vo, and Jacobs (2009) found enhanced negative potentials to high-arousal negative and to low-arousal positive words as compared to neutral ones in the time window from 80 to120 ms after stimulus presentation, indicating that not only arousal but also emotional valence plays a role for VEEEs. Similar to Scott et al., the authors concluded a speeded lexical access for both low-arousal positive and high-arousal negative words. Nevertheless, studies revealing VEEEs exhibit some methodological constrains: For instance, a high number of stimulus repetitions (Ortigue et al, 2004), an unequal number of stimuli from distinct word classes (Scott et al., 2009), or time pressure (Hofmann et al., 2009), so that a supposed lexical locus of emotion effects has not yet been fully elucidated. For detailed reviews on the results of neuroscientific research on emotion processing in words please also see Kissler, Assadollahi, and Herbert (2006) and Citron (2012).

To summarize, according to its timing the EPN has been assumed to reflect a semantic processing stage in word recognition (Kissler et al., 2007). Direct evidence of EPN and LPC with an onset only after lexicality effects in a lexical decision task with verbs by Schacht and Sommer (2009b) supported such an assumption. However, it is yet unclear whether this extends to other word grammatical classes than verbs. Direct comparison between different word classes should clarify the question. Very early emotion effects (e.g., Scott et al., 2009), however, may reflect processes before or during lexical access – in favour of the latter is the observed interaction of emotion with word frequency, a factor which is assumed to reflect lexical access (Sereno & Rayner, 2003). Taken together, it is still not clear whether emotional content impacts word processing on (pre-)lexical or semantic processing stages. The present work should contribute to the resolution of this issue by examining the interplay of emotion with other linguistic factors.

3. Summary of studies

Three studies were designed according to the following rationale: An orthogonal manipulation of emotional valence with a lexical factor (word frequency), and with a semantic factor (word concreteness) in a lexical decision task should reveal the functional locus of emotion effects in visual word processing. In case of on early lexical locus, an early interaction between emotion and word frequency was expected, in the case of a late semantic locus, an interaction between emotion and word concreteness was expected. In case that such interactions were found for specific ERP components (e.g., EPN or LPC), more precise conclusions about the processes reflected in the components can be drawn. A task manipulation that influences depth of processing of words will further shed light on timing, boundary conditions, and automaticity of emotion processing.

3.1. Early locus of emotion effects in visual word processing

The aim of **Study 1** was to functionally localize emotion effects in the stream of word processing employing a lexical decision task (LDT) under consideration of the factors word class and word frequency. Word class seems relevant for the timing of emotion effects as the EPN in verbs (Schacht & Sommer, 2009b) had a latency which was about 150 ms longer than in other studies with adjectives (Herbert et al., 2008), nouns (Kissler et al.,2007), or mixed grammatical word categories (Scott et al., 2009). The onsets of word frequency and of lexicality effects were considered indices of lexical access. Therefore, an interaction of emotion and word frequency before the lexicality effect would indicate an influence of emotion on lexical processing in words.

Word grammatical class (adjectives, nouns, and verbs), word frequency (high versus low) and emotional valence (positive, negative, and neutral) were orthogonally combined while other linguistic factors were controlled (word length and imageability). Stimulus material consisted in words like “lächeln” (to smile), which is a high-frequent positive verb, or “neidisch” (envious), which is a low-frequent negative adjective, and “Bericht” (a report), which is a neutral high-frequent noun. Arousal values were increased in negative words as contrasted with positive and neutral ones. During the experiment, subjects decided whether randomly presented letter strings were correct German words or not.

In line with previous findings, an advantage in performance with shorter reaction times (RTs) was exhibited by nouns compared to the other word classes (e.g. Kauschke & Stenneken, 2008), by high-frequent compared to low-frequent words (e.g. Scott et al., 2009), and by positive words compared to negative and neutral words (e.g. Schacht & Sommer, 2009b). In ERPs, main effects of word class and word frequency were obtained already from 100 ms post-stimulus, main effects of emotion followed with an onset at 300 ms.

An EPN component was present in all three word classes. Interestingly, in adjectives and in verbs there were significant differences for the positive versus negative, and for the positive versus neutral comparisons, but not for the negative versus neutral one, indicating preferential processing of positively valenced words. Both positive and negative nouns elicited augmented EPN amplitudes compared to neutral nouns. As reflected in a word class by emotion interaction, the EPN latency depended on the word class with main effects of emotion in adjectives and nouns starting earlier than in verbs (at about 250 ms and at 350 ms, respectively). Most importantly, lexicality effects, consisting in a centro-parietal negativity (Chwilla et al., 1995), started at about 250 ms after stimulus presentation, a timing that coincided with emotion effects or preceded them. A jackknife procedure revealed latencies of lexicality effects in the separate word classes as follows: 267 ms in adjectives, 270 ms in nouns, and 313 ms in verbs. Not only had the EPN a longer latency in verbs, but also the preceding lexicality effect. Region of interest (ROI) analysis with the electrodes PO7, PO8, PO9, PO10, O1, and O2, where the EPN was most prominent, showed that there were no EPN-like emotion effects before 250 ms. These results provide direct evidence in three separate word classes that emotional valence processing *as reflected in the EPN* takes place on a post-lexical processing stage in line with the assumption by Kissler et al. (2007).

At a later stage (400-550 ms post stimulus), an emotion effect on the LPC component was observed in adjectives and verbs, but not in nouns. Here, similarly to the EPN in these word classes, there was a distinct advantage of positive over negative valence. Importantly, both the EPN and LPC were observed just after the onset of lexicality effects and showed no interactions with the ongoing word frequency effects. Thus, on a semantic processing stage emotional valence seems to be processed independently of lexical factors like word frequency.

A very early emotion effect in the time range of the P1 was missing. Nevertheless, an interaction of word frequency and emotional valence was observed in the interval of 100 to 150 ms after stimulus onset. Emotional valence modulated the word frequency main effect with attenuated amplitudes to positive high-frequency words as compared with positive low-frequency words, which was not found for negative or neutral words. The interaction indicates that beyond the emotion-related EPN and LPC components, which seem to be based on the activation of word's meaning, emotional valence also may impact lexical access.

3.2. Late locus of emotion effects in visual word processing

To further specify the functional locus of emotion effects in visual word processing, in **Study 2,** a semantic factor (word concreteness) was chosen and combined orthogonally with emotional valence. An interaction of emotional valence with word concreteness would indicate a common locus of both factors on a late semantic processing stage in word recognition.

Word concreteness refers to whether the real world correspondence of a concept can be perceived by the senses or not. This factor has been shown to impact behaviour with concrete words being processed faster and more accurately than abstract ones (e.g., Schwanenflugel, Harnishfeger, & Stowe, 1988), as well as the ERP (e.g., Holcomb, Kounios, Anderson, & West, 1999). Two distinct ERP components were associated with word concreteness: The N400 – a broadly distributed negativity which is usually related with semantic processing (see also Kutas & Federmeier, 2000), and the N700, a frontal negativity which was most prominent in an imagery task (West & Holcomb, 2000). Such findings are usually interpreted within the scope of the extended dual-code theory by Holcomb et al. (1999), linking the N400 to contextual richness, and the N700 to mental imagery processing of concrete words. Until now, only one study has examined the interplay of emotion and concreteness in nouns, which revealed an interaction of both factors in the LPC (Kanske and Kotz, 2007), thus confirming a functional locus of emotion processing as reflected in the LPC at a semantic processing stage.

Concrete verbs (e.g., “umarmen” (to embrace)) and abstract verbs (e.g., “befreien” (to free)) which were emotionally positive, negative, or neutral were presented in a LDT similarly to Study 1. The stimulus material was controlled for word length and word frequency, but exhibited an increasing arousal difference from neutral, over positive to negative words. In performance, no advantage for emotional words was found, but the concreteness effect with shorter RTs for concrete relative to abstract words was replicated. Further, subjects reacted faster to neutral abstract than to emotional abstract words, no emotion effects were found in performance to concrete words. In ERPs, main effects of emotion started from 250 ms after stimulus presentation and were followed by main effects of concreteness (from 500 ms) which replicated the previously reported N700 component.

An EPN-like component to emotional as compared with neutral verbs was found for both concrete and abstract verbs. Most importantly, an interaction of emotion and concreteness was observed. First, it manifested in the time window from 250 to 300 ms as a latency difference of emotion effects between concreteness conditions with an EPN starting 50 ms earlier in concrete verbs than in abstract verbs. And second, at a later point in time, a scalp distribution difference between concreteness conditions was observed as indicated by ROI analysis with the electrodes PO7, PO8, PO9, PO10, O1, and O2, and revealed by profile analysis (McCarthy & Wood, 1985). Although the scalp distribution difference was obtained at a time course typical for the LPC (400-450 ms), all topographies of emotion effects in this interval were more similar to the EPN component, indicating the EPN to be sustained over time, and to recur with slightly different topographies, suggesting it may be generated by partly different neural substrates. All main effects of emotion resembled the EPN, while emotion-related LPC or P1 modulations were not observed at all. The interaction between emotion and concreteness in the EPN reveals a common locus of both factors within a semantic processing stage. Thus, emotion processing as reflected in the EPN can be considered to be based on activation of the meaning of words as supposed by Schacht and Sommer (2009b).

3.3. Automaticity of emotion processing in words

Emotion effects in words have been repeatedly found in passive viewing tasks (e.g., Kissler et al., 2007), indicating that emotional valence may be automatically processed when a word is perceived. However, different tasks set different demands on the level of word processing, which also has been shown to modulate emotion effects (Hinojosa et al., 2010; Schacht & Sommer, 2009b). Therefore, in **Study 3**, the stimulus material of Study 1 was employed in a superficial recognition task, demanding only a perceptual analysis of words, in order to bring boundary conditions of the emotion-sensitive ERP components to light. This task was chosen as it does not necessarily afford lexical or semantic access and, moreover, allows for a direct comparison with evolutionary prepared stimuli like emotional face expressions (cf. Schacht & Sommer, 2009a). This should guarantee same task-related processing demands for both face and word stimuli, in contrast to different tasks applied by Schacht and Sommer (2009a) where faces might have been processed on a perceptual and words on a lexico-semantic level.

Subjects performed on an easy and superficial word-face recognition task, whereas both stimuli types were emotionally positive, negative, or neutral. It can be assumed that decisions on the stimulus category can be made solely by perceptual analysis of the stimuli, thus the same level of processing in both domains is afforded. No emotion effects were found in performance. In ERPs, an EPN was found in faces from 150 ms post-stimulus, in contrast, in words there was no EPN component. An LPC was absent in both stimulus domains. In words, an emotion-related modulation in the interval from 50 to 100 ms, consisting in a parieto-occipital positivity and a frontal negativity, was observed, which was caused by both emotionally positive and negative words as compared to neutral ones. The timing (50-100 ms) of the emotion-related modulation in words was somewhat earlier than the P1 window usually explored (75-125 ms), and falls into the time range of the C1 component (cf. Stolarova, Keil, & Moratti, 2006) and the early phase of the P1 component. A similar effect of P1 modulation was found for happy versus neutral faces. Although words are not evolutionary prepared stimuli like faces, there was a very early detection of emotional valence, but only in faces there was further enhanced emotion processing.

Since very early ERP effects might be caused by other word features, an additional covariance analysis (ANCOVA) was performed to control for their influence. ANCOVA on occipito-parietal and frontal electrodes with the main factor Emotion revealed that early ERPs were unaffected by all other linguistic properties: word length, word frequency, trigram frequency and imageability.

4. Discussion and integration of results

Before the main issue of the functional locus of emotion effects in visual word processing is discussed, boundary conditions of emotion RT and ERP effects as the positivity bias, the role of word class and of level of processing will be disputed. And finally, several important implications of the present results will be outlined within the scope of the framework of word recognition and semantic representation models.

4.1. Boundary conditions of emotion effects in visual word processing

Emotional words showed an advantage in performance as compared to neutral ones only in Study 1, whereas speeded responses for emotional words were absent under the conditions of a superficial perceptual task with the same stimulus material (Study 3), and in abstract words even reversed emotion effects were observed with emotionally abstract verbs being processed slower than neutral abstract verbs (Study 2). Further, an advantage of positive material was observed in Study 1, indicating a preference for positive valence in language processing as found in other studies (Kanske & Kotz, 2007; Schacht & Sommer, 2009b). Hinojosa et al. (2010) proposed that when a task is superficial and can be solved based on perceptual analysis of stimuli, lexico-semantic aspects of the word may not be necessarily activated, which underlies the lack of emotion RT effects. Task demands may explain the results of Study 3, but also other factors may play a role for the heterogeneous performance results: For instance, abstract words may set high demands on memory retrieval, or the mixed presentation of words from other word classes may establish a minimal interpretative context, which has been shown to alter emotion effects (Schacht & Sommer, 2009b). Such suppositions should be clarified by future research. However, RT is the result of the interplay of several processing stages, thus an enhanced processing on a very early stage might go lost on later stages like response selection or motor activation. Due to their fine grained temporal resolution, ERPs allow for a closer look at the separate processing stages.

The RT advantage of positive words was also reflected by the ERPs in Study 1. Positive but not negative adjectives and verbs showed enhanced EPN and LPC amplitudes, and moreover, the early modulation of word frequency effects was only found in positive words. In the literature, the repeatedly found preferential processing of positive material (Herbert et al., 2006; 2008; Kissler et al., 2009) has been explained as a positivity bias which may be caused by the human tendency to interpret positive words as more self-relevant (for a discussion please see Herbert et al., 2009). Since the advantage of positive words was especially pronounced in adjectives, which often represent traits, the present results are in line with this assumption. The subsequent findings (Study 2 and 3) did not replicate an advantage of positive words neither in VEEEs, nor in the EPN. Thus, self-relevance might be an aspect of the meaning of emotional words which is not necessarily, automatically activated. Emotion research based on appraisal theories of emotion, for example the component process model of emotion (Scherer, 2001), may be more appropriate to address the issue. Interestingly, in all three experiments positive words featured lower arousal values than negative words but both positive and negative words elicited similar emotion effects (Study 2 and 3), or positive words were even preferentially processed (Study 1). Therefore, all three emotion-sensitive ERP components (VEEEs, EPN, and LPC) may not just reflect arousal processing as supposed by Kissler et al. (2007), but valence specific processing. The present results are in line with motivated attention theory (Lang et al., 1998), which assigned an eminent role to the valence dimension.

In the literature, longer latencies of emotion effects were reported in verbs (Schacht & Sommer, 2009b) relative to other word classes (Herbert et al., 2008; Kissler et al., 2007). Study 1 showed in a direct comparison between word classes a latency difference of emotion effects with EPN in verbs occurring 100 ms later than in adjectives and nouns. Verbs and nouns differ in a number of features: For instance, syntactic and morphological processes they involve (for a review Vigliocco, Vinson, Druks, Barber, & Cappa, 2011), nouns are easier to remember, and are acquired earlier in life. Further research is needed to disentangle the reasons of timing difference of the EPN in the different word classes. Still, semantic differences between nouns and verbs remain the most likely main source of possible processing differences: Nouns are usually single objects, verbs, to the contrary, represent events, actions, or activities which involve objects as predicates. Moreover, in emotion research on words, relatively concrete nouns have mostly been employed, thus a difference in concreteness might be a possible source for timing differences of the EPN in verbs and nouns. In line with this idea, in Study 2 concrete verbs as compared with abstract verbs showed a shorter latency of emotion effects (at about 250 ms post-stimulus) which was comparable with the onset of emotion effects in other word classes (e.g., Kissler et al., 2007), and with the onsets of the EPN in adjectives and nouns in Study 1. The timing difference in the EPN latency indicated that verbs’ concreteness is a decisive factor for the processing of their valence. It is conceivable, that concrete verbs are semantically richer, and have more predicates than abstract verbs. Thus, they are possibly easier to retrieve and may be processed similar to nouns. The difference in latency of the EPN in nouns and verbs as found in Study 1 may have been caused by semantic differences, particularly in concreteness between word categories. In future research, concreteness and other semantic differences (e.g., action versus object words) should be taken into consideration (cf. Vigliocco, Vinson, Arciuli, & Barber, 2008) to delineate differences in emotion processing between word classes.

Specific tasks may not just impose different demands on the level of word processing, but may also influence to what extent certain aspects of a word are processed or rather what kind of representations are activated. The lexical decision task requires at least the activation of lexical representations of words (Balota, 1990). In two experiments using LDT, an EPN was observed, whereas a LPC was partly or completely missing. Thus, processing of emotion content of a word took place as indicated by the EPN, but not necessarily in an elaborated manner as assumed to be reflected in the emotion-sensitive LPC (Schacht & Sommer, 2009b). The lack of an EPN or LPC in the superficial task (Study 3) indicates that processes reflected in these components do not take place automatically, at least not to the same degree as for evolutionary prepared stimuli like faces. The findings are in line with the assumption of Hinojosa et al. (2010) that at least a minimum of lexico-semantic activation is a prerequisite for those components to occur in words. In Study 3, although words seem to have been processed only on a perceptual level, they elicited very early emotion effects in the early phase of the P1, indicating that emotional valence may be detected fast in visual word processing as an especially relevant or salient aspect of words. The VEEEs are a replication of similar effects reported previously (Hoffmann et al., 2009; Scott et al., 2009) and indicate that the words have been perceived but conceivably not fully or elaborately processed. The lack of VEEEs in Study 1 might argue for their task-dependence. However, a very recent study showed task-independent VEEEs, supposing emotion effects prior to 200 ms post-stimulus might be even automatically elicited (Bayer, Sommer, & Schacht, 2012). The functional meaning of the VEEEs will be discussed in more detail in the following section. According to the present results it can be concluded that emotion effects (at least EPN and LPC) in word processing depend on the depth of processing required by the task as shown previously (Bayer et al., 2012; Hinojosa et al., 2010; Schacht & Sommer, 2009b).

4.2. Functional locus of emotion effects in visual word processing

Three separate ERP components (EPN, LPC and VEEEs) of emotional valence processing were observed in the reported experiments. The EPN was present in a LDT but it was absent in a superficial task employing the same stimulus material. LPC effects were observed only in the LDT and varied across word classes. VEEEs showed exactly the opposite pattern of results compared to the EPN with a C1/P1 modulation under the condition of superficial processing. VEEEs were not observed in a LDT, but there was an interaction of emotion and word frequency with a similar timing. The results indicate that an interpretation of the initial latency of emotion effects is insufficient to localize which stages in visual word processing are impacted by emotion. Instead, the latencies of the separate emotion-related components should be considered in relation to effects of other linguistic factors. Moreover, the emotion-related components seem to exhibit distinct functional loci in word processing and are therefore discussed separately.

Two studies yielded direct evidence for the functional locus of processes reflected in the EPN. In Study 1, lexical access was denoted by the timing of word frequency and lexicality effects. The EPN occurred only after the onset of both word frequency and lexicality effects in all three word classes, so that a post-lexical locus of the EPN can be assumed. This finding was first shown by Schacht and Sommer (2009b) in verbs, and is hereby extended to the two further word classes. The assumed binding of attention resources reflected in the EPN may therefore be based on activation of the semantic representation of a word. The EPN modulations by word concreteness, which is a semantic factor, in Study 2 reinforce the assumption of a semantic locus in visual word processing. It is, however, conceivable that lead-in processes of the EPN take place in parallel with lexical access, because at least in the word classes of adjectives and nouns lexicalitiy effects and the EPN were observed simultaneously, which is in line with current reports of brain responses to lexical and semantic information with comparable timings (Hauk et al., 2012).

In line with previous findings (Fischler & Bradley, 2006; Naumann et al., 1992; Schacht & Sommer, 2009a), a LPC was observed in a LDT only after the onset of lexicality effects, but not in a superficial task with the same stimulus material. An assumption of a late locus in visual word processing of LPC which reflects elaborate higher-level cognitive evaluation (Schacht & Sommer, 2009b) is also consistent with the present data. Interestingly, an RT advantage for emotional words as compared to neutral ones was observed just when an LPC modulation was obtained. Thus, a LPC modulation might also be reflective of response selection processes.

Most intriguing is the question of the functional locus of very early emotion-related ERP modulations (Study 1 and 3) and the mechanisms underlying the effects. An interaction of word frequency and emotion in the time course of the P1 (Study 1) indicates that valence is at least partly processed during lexical access since word frequency effects are assumed to denote lexical activation (Sereno & Rayner, 2003). In Study 3, using the same stimulus material as in Study 1, very early emotion effects (50-100 ms) were observed for both valence conditions with more positive amplitudes at posterior sites for emotional relative to neutral words. VEEEs were previously observed in studies with stimulus repetition (Ortigue et al., 2004), short presentation durations (Bernat et al., 2001), or under time pressure (Hofmann et al., 2009). The RTs are somewhat decreased in Study 3 compared to the results of the other studies, so that a superficial or speeded processing might constitute a prerequisite for VEEEs to occur. Most importantly, according to their timing, the functional locus in visual word processing of VEEEs may be on both perceptual and lexical processing stages. Generally, C1 and P1 modulations were associated with activation in primary visual area and ventral and dorsal extrastriate cortex, and are assumed to reflect perceptual processing of visual stimuli (Di Russo, Martinez, Sereno, Pitzalis, & Hillyard, 2002; Di Russo et al., 2007; Tobimatsu & Celesia, 2006). In words, C1 and P1 modulations were associated with processing of orthographic features (Proverbio & Adorni, 2009). Moreover, the timing of the VEEEs in Study 3 with latency from 50 ms post-stimulus seems to be too early to reflect semantic or even lexical processing: For instance, word frequency effects have been found from a latency of 100 ms post-stimulus and not earlier. In contrast, a comparable, early timing has been found for word length effects (Assadohalli & Pulvermüller, 2003; Hauk & Pulvermüller, 2004). Further, the task was demanding of perceptual analysis but not necessarily of lexical or semantic access. Conclusively, VEEEs may reflect early visual code processing of emotional words, or also sublexical level processing, like single letter or bi- or trigram frequency processing. An open question is which mechanisms underlie these modulations. Since it is less conceivable that semantic activation has occurred at that early point in time (but see also Rabovsky, Sommer, & Abdel Rahman, 2012), it might alternatively be suggested that associative conditioning between the visual word form and its emotional content based on a lifetime experience may explain such early ERP modulations. For example, Stolarova et al. (2006) found C1 modulations based on the acquired affective content of conditioned simple visual grating patterns. Most recently, Schacht, Adler, Chen, Guo, and Sommer (2012) showed in a reinforcement learning task with previously unknown Chinese words, that association with positive outcome may induce VEEEs with a scalp distribution of a posterior positivity with a timing prior to 200 ms from stimulus onset. The results from the reinforcement learning paradigm indicate, moreover, that VEEEs may occur in the absence of biological preparedness and semantic meaning. The boundary conditions of VEEEs, their underlying mechanisms and their exact functional locus in word processing remain, however, a matter of future research.

In conclusion, emotion processing impacts multiple stages of visual word processing: VEEEs conceivably reflect perceptual processing and/or (sub-)lexical processing, EPN and LPC seem to be based on processing of the semantic content of words. In the following chapter will be discussed how the present findings can be integrated within the scope of the standard model of word recognition and semantic representation.

4.3. Implications for models of visual word recognition and semantic representation

A main assumption of the standard model according to Neumann (1990) is that lexical and semantic representations are stored separately of each other, and thus at least three processing stages should be considered in visual word processing. In the following, the time course of visual word processing stages as described by the present findings will be outlined and the question how emotion is represented within the scope of word recognition and semantic representation models will be discussed.

4.3.1. Time course of visual word processing

According to the latencies of word frequency and of lexicality effects in the present data, activation of lexical representations may be estimated to the time range from 100 ms to 250 ms. Lexical access may take longer in the word class of verbs as indicated by the onset of lexicality effects at about 300 ms which was about 40 ms later than in the other word classes. The role that word class plays for word representations is controversially discussed in current literature (for a review, please see Vigliocco et al., 2011). When semantic differences were controlled, no ERP differences between verbs and nouns were evident indicating that word class is not a crucial factor for the organisation of representation. However, adjectives have been examined less frequently, and the present finding of an ERP modulation in the time range of the P1 component by word class may indicate that also grammatical class is processed during lexical access or it may be a part of the lexical representation of words. Since grammatical class has not been in focus of the present experiments, the functional locus of grammatical class in word processing is a question of further research.

Semantic access may be estimated to 250 ms post-stimulus according to the latency of the emotion-related EPN, which partly coincided with lexicality effects. In Study 2, EPN was long-lasting and recurred with slightly different distributions. A much later onset was observed for effects of concreteness, up to 500 ms post-stimulus. The onset differences between emotion and concreteness effects indicate that emotion was processed preferentially relative to concreteness. Whether emotion is the initial semantic feature activated when a word is read, would be though a matter of future research. Taken together, the present findings are in line with an assumption of a flexible, non-rigid time course of lexical and semantic access with overlapping processing stages in visual word recognition.

4.3.2. Representation of emotion within the scope of the standard model

Within the scope of the standard model two possible assumptions for the representation of emotion in the cognitive system can be hypothesized based on the present findings. A first, strong assumption would be that emotion is completely represented as a part of the semantic memory system. Considering the semantic locus of EPN and LPC which are the commonly found emotion-related ERP components such an assumption appears plausible. The second assumption would be that emotion is mainly represented in the semantic memory system, but emotion may also be, at least to some extent, a part of the lexical representation of words (in analogy to word frequency). The word frequency by emotion interaction and the VEEEs are in favour of the latter assumption.

Although current word recognition models assume that higher level processing stages can influence lower level stages, most of them propose that only the adjacent stages can interact. For instance, the dual route cascaded model of visual word recognition and reading aloud (DRC; Coltheart at al., 2001) assumes that the lexical-semantic route is composed of layers, containing (i) visual feature units, (ii) letter units, (iii) orthographic input lexicon and (iv)the semantic system. Adjacent layers of the model influence each other in both directions in an excitatory and an inhibitory way, except for communication between visual feature and letter layers, where information only flows from visual features to letters. Thus, semantic content would not be able to influence sublexical or perceptual processing stages directly, but only via the lexical stage. If this holds true, the VEEEs found in Study 3 (presupposed VEEEs are based on perceptual or sublexical processing of words) can only be explained by the second assumption of emotion representation, that is, emotion is both a part of the lexical and the semantic representations of words. In contrast, if emotion is just represented as a semantic aspect, the finding of VEEEs would set a challenge to the DRC and word recognition models in general, entailing even more flexible, highly interactive word recognition processes.

In addition, the present results have implications for some assumptions of current semantic representation models. For instance, language and situated simulation theory (LASS;

Barsalou, Santos, Simmons, & Wilson, 2008) assumes, similarly to the standard model, separable and interactive linguistic system (responsible for lexical representations) and a simulation system (responsible for semantic representations). According to LASS the brain captures modal states of perception, action and introspection and simulates them in order to represent semantic meaning. LASS theory also postulates that representation of meaning of abstract words is grounded in experience, in particular, by simulation of situations/context, and possibly may be strongly associated with emotions (Kiefer & Pulvermüller, 2011). Although conceivably also due to task specifics, because LDT is requiring lexical and not necessarily semantic level of processing, the present finding of late and reduced emotion effects in abstract compared to concrete words is at variance with the embodiment assumption of strong association with emotion for abstract words. Nevertheless, evidence in favour of the embodiment hypothesis was found for abstract emotion words, that is, words that directly refer to emotional states, (Moseley, Carota, Hauk, Mohr, & Pulvermüller, 2011), thus the conclusion above may only refer to abstract emotion-related words as employed in Study 2.

Independent of the considerations above, the present findings indicate that emotion impacts visual word processing on multiple levels and should therefore be considered by and integrated in both word recognition and semantic representation models. The results also substantiate the need for integration of word recognition and semantic representation models. For instance, in the current version of the DRC (Coltheart et al., 2001) the semantic system has not been specified at all, thus a simulation of emotion effects would be unfeasible.

5. Future directions

In my dissertation I examined the locus of emotion effects in visual word processing by applying the ERP method in a repeated measures within-subjects factorial design. A challenge for future research would be to regard inter-individual differences, since a word may be associated with completely different emotional connotations in two persons based on their personal experience. A promising approach might be to apply single trial analysis and other statistical methods to ERPs, for example linear mixed-effects models (LMMs) which have several advantages compared to analysis of variance (cf. Amsel, 2011; Baayen, Davidson & Bates, 2008).

Further, other linguistic factors and their interplay with emotion in word processing should be considered. Of priority would be the question of the functional locus of VEEEs on a perceptual and/or (sub-)lexical processing stage of words. For this purpose visual feature (word length) and sublexical factors (letter, bi- and trigram level) manipulations should be combined orthogonally with a manipulation of emotion following the same rationale as the studies outlined in the dissertation. While the question of the functional locus of VEEEs is of high priority, also other linguistic factors such as age of acquisition, word familiarity, imageability and semantic features may contribute to the delineation of boundary conditions of emotion effects in visual word processing.

Moreover, the conceptual structure of emotion representation should be further specified and considered by semantic representation models. Current models assume that meaning is represented by means of conceptual features, which also might apply to emotion. Hence, rather models like the component process model of emotion by Scherer (2001) than the dimensional models of emotion would be appropriate for such a differentiation. The component process model assumes separate continuous evaluation (appraisal) checks, for instance, of relevance, novelty, intrinsic pleasantness, goal conductiveness, or coping potential, which may constitute the emotional meaning of words as distinct emotion features. Future research should also address whether such emotion aspects may play a different role for the distinguishable emotion-related ERP components, as suggested by LPC modulations to self-relevance (Herbert, Pauli, & Herbert, 2011), and thus may further specify their functional locus in visual word processing.

Manuscript list

Study 1: Palazova, M., Mantwill, K., Sommer, W., & Schacht, A. (2011). Are effects of emotion in single words non-lexical? Evidence from event-related brain potentials. *Neuropsychologia, 49*(9), 2766-2775.

Study2: Palazova, M., Sommer, W., and Schacht, A. (submitted). Interplay of emotional valence and concreteness in word processing: An event-related potential study. *Brain and Language*

Study 3: Rellecke, J., Palazova, M., Sommer, W., & Schacht, A. (2011). On the automaticity of emotion processing in words and faces: event-related brain potentials evidence from a superficial task. *Brain and Cognition, 77*(1), 23-32.

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Eidesstattliche Erklärung

Hiermit erkläre ich,

1) dass ich die vorliegende Arbeit selbständig und ohne unerlaubte Hilfe verfasst habe,

2) dass ich mich nicht anderwärts um einen Doktorgrad beworben habe und noch keinen Doktorgrad der Psychologie besitze,

3) dass mir die zugrunde liegende Promotionsordnung vom 3. August 2006 bekannt ist.

Berlin, den 04. Mai 2012 Marina Palazova