Brain & Language 137 (2014) 142–147

Contents lists available at ScienceDirect

Brain & Language

journal homepage: www.elsevier.com/locate/b&l

Short Communication

A familiar font drives early emotional effects in word recognition

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ARTICLE INFO

Article history:
Accepted 17 August 2014
Available online 16 September 2014

Keywords:
Visual word recognition
Valence
Familiarity
Font
Event-related potentials

ABSTRACT

The emotional connotation of a word is known to shift the process of word recognition. Using the electroencephalographic event-related potentials (ERPs) approach it has been documented that early attentional processing of high-arousing negative words is shifted at a stage of processing where a presented word cannot have been fully identified. Contextual learning has been discussed to contribute to these effects. The present study shows that a manipulation of the familiarity with a word's shape interferes with these earliest emotional ERP effects. Presenting high-arousing negative and neutral words in a familiar or an unfamiliar font results in very early emotion differences only in case of familiar shapes, whereas later processing stages reveal similar emotional effects in both font conditions. Because these early emotion-related differences predict later behavioral differences, it is suggested that contextual learning of emotional valence comprises more visual features than previously expected to guide early visual-sensory processing.

1. Introduction

Reading a word is a highly complex and well examined skill. An average reader is almost effortlessly able to correctly recognize a word within the first 150–200 ms (Sereno & Rayner, 2003). The standard approach for assessing word recognition is the lexical decision task, wherein participants are asked to judge whether a presented string of letters is a word or not (Pexman, 2012). Forty years of research using this task have identified a number of orthographic and phonological word characteristics, like word frequency or number of phonemes that affect the process of word recognition. More recently, studies have begun to add evidence of emotional influences. The emotional connotation of a word in terms of its valence, i.e. the hedonic value of the word ranging from positive to negative, and/or arousal indicating the excitement a word elicits (from low to high) has been reported to affect word recognition. The more arousing a word is, the faster this word is recognized (Hofmann, Kuchinke, Tamm, Võ, & Jacobs, 2009; Larsen, Mercer, Balota, & Strube, 2008). And also words that are evaluated more positively are recognized faster (Briesemeister, Kuchinke, & Jacobs, 2011; Kousta, Vinson, & Vigliocco, 2009; Larsen et al., 2008), whereas negative words are often reported to be processed slower than neutral words (Hofmann et al., 2009; Kuchinke et al., 2005; Larsen et al., 2008, but read Kousta et al., 2009, for a discussion). This disadvantage of negative words can be explained by affective mechanisms that disengage attention more slowly from negative stimuli (Pratto & John, 1991; Wentura, Rothermund, & Bak, 2000).

At the neural level, it has been shown that the recognition of emotional words (compared to neutral ones) additionally activates brain regions in emotion and semantic processing networks including the orbitofrontal cortex and the amygdala, and the anterior and posterior temporal lobes respectively (Herbert et al., 2009; Kuchinke et al., 2005; Schlochtermeier et al., 2013). Such activations are in line with the assumption of word evaluation following the processes of word identification. A similar conclusion is supported by recent event-related potential (ERP-) studies that, based on the high temporal resolution of the electrocortical activity, are used to examine the timeline of emotional effects in word recognition. Emotional effects in ERPs have been documented at post-identification stages during the time frame of the early posterior negativity (EPN, 200–300 ms after stimulus presentation) and at later controlled processing stages, as reflected by positive deflections around 400–800 ms (the late posterior positivity, LPP, over temporo-occipital brain regions; e.g., Hofmann et al., 2009; Kissler & Herbert, 2013; Kissler, Herbert, Peyk, & Junghöfer, 2007; Scott, O'Donnell, Leuthold, & Sereno, 2009; for a recent review see Citron, 2012). Moreover, replicating the pattern of behavioral effects, Kissler and Herbert (2013) have shown that activity reflecting word identification in the ERP can be detected

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http://dx.doi.org/10.1016/j.bandl.2014.08.007
0093-934X/

earlier for emotional compared to neutral words leading to the assumption of a processing facilitation for emotional words.

More recently, a number of studies using the lexical decision task also reported much earlier effects of emotional words in the ERPs, namely effects on the P1 component around 100 ms (Bayer, Sommer, & Schacht, 2012; Hofmann et al., 2009; Kissler & Herbert, 2013; Scott, O'Donnell, Leuthold, & Sereno, 2009). The P1 complex summarizes the first positive (P1) deflections in the ERP amplitudes that have traditionally been associated with visual-sensory processing, i.e. encoding of visual stimulus attributes, and attentional resource allocation towards the presented stimulus (e.g., Luck, Woodman, & Vogel, 2000). Of particular interest is that the timing of these effects, and thus of the earliest emotional effects visible in the ERPs in visual word recognition, indicates a level of processing where a presented word stimulus cannot have been fully identified. The nature of these early emotional ERP effects is less well explained. Although some emotion models propose that automatic affective evaluation is likely to occur already pre-attentively at pre-conscious processing stages (e.g. the affective primacy hypothesis, Murphy & Zajonc, 1993, and the automatic vigilance model, Pratto & John, 1991), and thus bypass perceptual analysis, others argued that it is highly unlikely that an affective analysis takes place before the stimuli are categorized (e.g., Lai, Hagoort, & Casasanto, 2012; Nummenmaa, Hyönä, & Calvo, 2010; Storbeck, Robinson, & McCourt, 2006).

We believe that contextual learning contributes to the emotional effects in language processing (Barrett, Lindquist, & Gendron, 2007; Panksepp & Watt, 2011). A likely mechanism how emotional connotation modulates early ERPs could rely on conditioned associations between the visual features (of single letters, bigrams, syllables or the word shape) and the word level representation for words with an emotional connotation (Fritsch & Kuchinke, 2013). According to this hypothesis, activation of such conditioned associations early in word recognition indicates emotional significance and triggers a facilitated recognition of the visual stimulus. If the assumption is correct, then the participants' familiarity with the visual features of the verbal stimuli should also interfere with the early emotional ERP effects, because repeated experiences with a particular emotional word (and its printed letters) should have strengthened the conditioned associations to its lexical representation during every day reading. We report an investigation of emotional ERP effects in word recognition where the familiarity with the words' visual features is manipulated by the use of a highly familiar font ('ARIAL') in comparison to an unfamiliar, unpublished font ('TIMELINE', Typedesign by Diana Kettern, 2012, http://cargocollective.com/dianake/FONT-TIMELINE) (see Fig. 1 for an example).

2. Methods

2.1. Participants

Twenty-one native German speaking and neurologically healthy participants (12 women, 9 men, mean age = 25.9 years) took part in the study in return for course credits. According to the Edinburgh Handedness Scale, all participants were right handed. The experiment was approved by the local ethics committee of the Faculty of Psychology, Ruhr-University Bochum, and written informed consent was obtained from all participants.

2.2. Materials and procedure

Seventy-eight negative and 78 neutral German nouns of 4–8 letters length were selected from the BAWL-R database (Võ et al., 2009). They were matched for their average level of imageability,

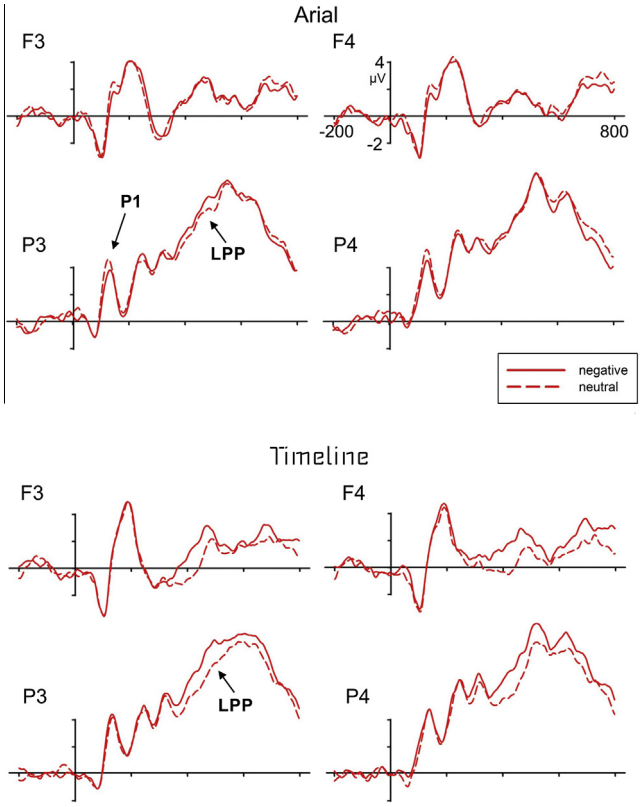

Fig. 1. ERP time courses at selected electrodes for negative (solid) and neutral (dashed) words in both font conditions (upper: Arial, lower: Timeline).

(CELEX-) frequency per million, bigram frequency, orthographic neighborhood size, frequency of orthographic neighbors, as well as their mean number of letters, syllables and phonemes (all pairwise *t*-values <1.14), so that they only differed in their normative valence and arousal values (both pairwise tests $p < .0001$, Table 1). Words with valence ratings between −0.5 and 0.5 (e.g. 'BASIS' [base]) were classified as neutral (mean valence = 0.10, arousal = 2.32), and words with valence ratings between −.75 and −3 as negative (e.g., 'BOMBE' [bomb], mean valence = −1.60, arousal = 3.46). Meaningless nonwords of 4–8 letters length were created by changing 1 to 3 letters of 156 words that were not part of the stimulus set, matched to the word lists on number of letters ($F < 0.25$).

For the EEG recording session participants were seated in a comfortable chair in front of a 22 in. LCD screen approximately 80 cm in front of the participants' eyes in a sound and electrically shielded, dimly illuminated and air conditioned laboratory. The lexical decision paradigm started with twenty training trials that were not part of the stimulus set to familiarize the participants

Table 1
Descriptive statistics of words for the emotional conditions.

	Negative	Neutral
n	78	78
Valence	−1.60 (.06)	.10 (.03)
Arousal	3.46 (.07)	2.32 (.04)
Imageability	3.95 (.12)	3.96 (.16)
Frequency	75.53 (8.80)	79.26 (8.95)
Bigram frequency	3386 (180)	3677 (212)
Orthographic neighborhood size	1.40 (.21)	1.78 (.27)
Frequency of orthographic neighbors	76.04 (37.23)	65.42 (24.04)
# Of letters	5.91 (.12)	5.92 (.14)
# Of syllables	1.83 (.07)	1.88 (.05)
# Of phonemes	5.15 (.13)	5.26 (.13)