Experimental Brain Research (2019) 237:2423–2430
https://doi.org/10.1007/s00221-019-05600-4

RESEARCH ARTICLE

Differentiating emotion-label words and emotion-laden words in emotion conflict: an ERP study

Juan Zhang[1,3] · Chenggang Wu[1] · Zhen Yuan[2,3] · Yaxuan Meng[1]

Received: 26 April 2019 / Accepted: 5 July 2019 / Published online: 13 July 2019

Abstract

Despite recent increased attention to emotion conflict, little is known about whether emotion-label words (e.g., sadness, happiness) and emotion-laden words (e.g., death, birthday) function similarly in emotion conflict (i.e., a conflict between the target and distractor in emotion involvement), because the majority of the previous studies implicitly mixed the two. The present study aimed to compare emotion-label words and emotion-laden words in emotion conflict using a flanker task. Specifically, participants ($N=21$) were asked to judge the valence of the target words that were vertically surrounded by the words with same (congruent) or different (incongruent) valence as being negative or positive. The behavioral results suggested that negative emotion-laden words were processed faster and more accurately than negative emotion-label words. ERP data further showed that negative emotion-label words elicited larger N200 than negative emotion-laden words on the left hemisphere, while such a difference was found for positive words on the right hemisphere. Moreover, emotion-laden words elicited smaller N200 in the incongruent condition than in the congruent condition, whereas no such a distinction was observed for emotion-label words. The findings suggest different cognitive and neural correlates of emotion-label words and emotion-laden words in emotion conflict.

Keywords Emotion conflict · Emotion-label words · Emotion-laden words · N200

Introduction

When performing a task, one needs to concentrate on the task and ignore distractors. The ability to resolve conflict processing is required to successfully complete a task (Ma et al. 2016; Posner et al. 2007). Therefore, conflict detection and resolution, a core element of cognition control, has been widely investigated in the last decades (Botvinick et al. 2001). Emotion stimuli, such as emotion faces (Frühholz et al. 2011) and emotion words (Citron 2012; Kanske and Kotz 2010), gain priority in attention and processing due to their salience. More specifically, such salience has been demonstrated to speed up conflict resolution (Kanske 2012), suggesting an interaction between emotion and cognition (Dolcos et al. 2011). For example, Kanske and Kotz used a flanker task to compare emotion words and neutrals words in cognitive conflict. The results showed that emotion words reduced conflict interference, and such an effect has been demonstrated for both negative emotion words (Kanske and Kotz 2010) and positive emotion words (Kanske and Kotz 2011a).

However, the majority of previous studies focused on cognitive conflict rather than emotion conflict. Cognitive conflict tasks usually require one to process stimuli that are not associated to emotions, such as color decisions, while emotion conflict tasks often instruct participants to process emotion stimuli on emotion-related dimensions, such as valence evaluation. For example, in one emotion conflict task, participants need to decide the valence of the target words and ignore the words that are above and below the target words. The adjacent and target words could be of the same or opposite valence (Alguacil et al. 2013). One noticeable difference between the two abovementioned tasks is whether emotional content is implicitly (cognitive conflict) or explicitly (emotion conflict) processed. In fact, cognitive conflict and emotion conflict are found to be different at both the neural (Egner et al. 2007)

✉ Chenggang Wu
chenggang.wu@connect.um.edu.mo

[1] Faculty of Education, University of Macau, E33, Av. da Universidade, Taipa, Macau, China

[2] Bioimaging Core, Faculty of Health Sciences, University of Macau, Macau, China

[3] Center for Cognitive and Brain Sciences, University of Macau, Macau, China

and behavioral (Soutschek and Schubert 2013) levels. For example, Soutschek and Schubert (2013) found that working memory load selectively constrained cognitive conflict, while the emotional Go/Nogo task impaired conflict regulation in emotion conflict. The data confirmed the dissociable functions of cognitive conflict regulation and emotion conflict regulation. Similarly, some studies offered event-related potential (ERP) evidence showing the difference in conflict effect between cognitive conflict and emotion conflict for negative stimuli (Zinchenko et al. 2015) and positive stimuli (Zinchenko et al. 2017).

While recent studies have confirmed the distinction between the two kinds of conflict, the majority of them concentrated on faces (Zinchenko et al. 2015, 2017) rather than words. For example, Zinchenko et al. (2017) investigated how positive emotion influenced the processing of the vocalization of voices that might be incongruent or congruent with the facial expressions. Zinchenko et al. (2017) found that positive stimuli elicited a larger congruency effect (incongruent-congruent) than neutral stimuli; however, no such a difference was found for cognitive conflict, demonstrating that positive emotion could influence emotion conflict rather than cognitive conflict. Along with the behavioral data, electrophysiological evidence was found only in emotion conflict such that positive emotion elicited different cortical activations between congruent and incongruent conditions. Although Zinchenko and his colleagues provided much evidence to show the differences between emotion conflict and cognitive conflict, they were unclear whether such differences could be observed in visual emotion word recognition since they only examined the matching of vocalizations and facial expressions.

In addition, studies that examined emotion effects in conflict processing using visual emotion words concentrated only on cognitive conflict, not emotion conflict (Kanske and Kotz 2010, 2011a, b). One exceptional study investigated emotion conflict using emotion words and neutral words in a flanker task and suggested common and separate brain mechanisms for the two conflicts (Alguacil et al. 2013). Alguacil et al. (2013) asked participants to perform two kinds of flanker tasks. The one is to decide the target word's semantic category (cognitive conflict: the target word's category could be inconsistent or consistent with the adjacent words). The other is to decide the valence of the target word (i.e., emotion conflict: the target word's valence could be the same as or different from the adjacent words). Despite the similar behavioral results of the two tasks, the electrophysiological evidence supported the dissociable brain mechanisms of the two conflicts. Late positive component (LPC) was modulated by congruency in emotion conflict rather than in cognitive conflict, such that larger LPC was elicited in the incongruent condition than in the congruent condition, whereas the effect was not observed for cognitive conflict (Alguacil et al. 2013).

Although Alguacil et al. investigated emotion words and neutral words in cognitive conflict and emotion conflict, one unresolved problem was that Alguacil and her colleagues only examined emotion-laden words instead of emotion-label words. Broadly, emotion words (Citron 2012) are referred to as the words that label affective states (i.e., emotion-label words) or elicit some emotion (i.e., emotion-laden words). Most of the previous studies unconsciously regarded emotion-label words (e.g., sadness, happiness) and emotion-laden words (e.g., murder, promotion) as the same. However, increasing evidence has recently indicated that emotion-label words and emotion-laden words undergo different cognitive processing (Altarriba and Basnight-Brown 2011; Kazanas and Altarriba 2015, 2016; Knickerbocker and Altarriba 2013) and involve different brain mechanisms (Wang et al. 2019; Zhang et al. 2017). For example, Kazanas and Altarriba recently compared the priming effects produced by emotion-label words and emotion-laden words in two experiments (one unmasked priming and the other masked priming). The results revealed that emotion-label words elicited a larger priming effect than emotion-laden words. Zhang and her colleagues additionally showed that emotion-label words elicited stronger cortical activation than emotion-laden words even less than 200 ms after stimuli onset (Zhang et al. 2017). Therefore, the current study aimed to examine the emotion conflict by comparing emotion-label words and emotion-laden words in emotion conflict by ERP measurements that could uncover time courses of emotion activation in emotion conflict processing.

N200, the main ERP component in the present study, is an early conflict-processing-relevant ERP component at frontal sites, and numerous studies have shown that incongruent trials are accompanied by an enhanced N200 at frontal sites as compared to congruent trials (Kanske and Kotz 2010; Van Veen and Carter 2002). Furthermore, Kanske and Kotz (2010, 2011a) found that both negative emotion words and positive emotion words facilitated cognitive conflict with enhanced N200 compared with neutral words, suggesting that both threatening and reward stimuli facilitated conflict resolution.

Despite accumulated evidence indicated that emotion-label words and emotion-laden words are distinct at cognitive and neural correlates (Zhang et al. 2017), another unresolved issue in previous studies was that there was lacking theoretical account for such distinction. A systematic explanation for asymmetric processing speed for positive stimuli and negative stimuli, namely density hypothesis (Unkelbach et al. 2008), provides explanatory power for the distinction between emotion-laden words and emotion-label words. The hypothesis was initially used to explain the processing advantage for positive information than negative information. Such information also includes lexical information covering both emotion-label words and emotion-laden words. Indeed, positive emotion-label words are clustered

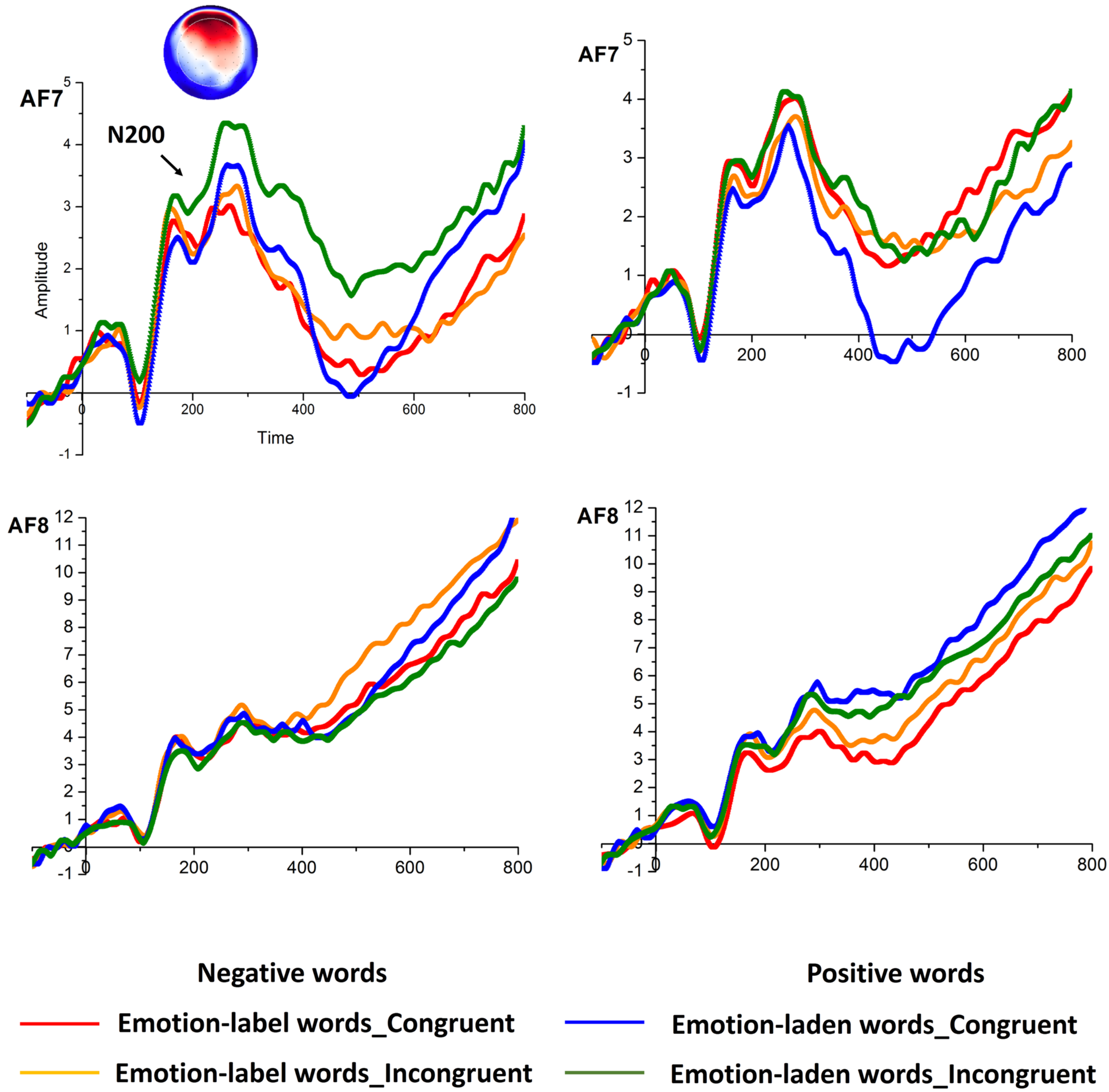

Fig. 1 Grand averages and scalp discrimination for negative emotion-label words, positive emotion-label words, negative emotion-laden words, and positive emotion-laden words in congruent and incongruent condition at selected electrodes, amplitude (μV) and time (ms)

densely whereas negative emotion-label words are stored sparsely. For example, positive emotion-label words, such as happiness, satisfaction, delight, desire, are more related with each other than negative emotion-label words, such as fear, anger, or sadness, in agreement with the notion that emotion is more discrete for negative emotion than positive emotion (Lench et al. 2011). However, emotion-laden words (e.g., death, rape, diamond, money) do not describe affective state directly and provoke emotion by connotation. Hence, emotion-laden words need to connect to emotion-label words implicitly to activate emotion. However, emotion-laden words associate with emotion-label words in multiple and unpredictable ways, especially for negative ones. For example, word "catastrophe" can elicit much related negative emotion, such as "sadness", "fear", or "worry". It is reasonable to assume that negative emotion-laden words (e.g., catastrophe) are clustered and surrounded by the separate negative emotion-label words. For positive emotion-laden words, by contrast, are assumed to cluster in density, in line with positive emotion-label words. For example, word "diamond" could remind us of beauty, value, and so on, all of which could activate positive emotion and due to positive emotion clustering, positive emotion-laden words are assumed to be clustered at the same time. The current study aimed to provide initial support for these hypotheses.

Taken together, previous studies mostly investigated cognitive conflict rather than emotion conflict, and recent evidence indicates that the two conflicts are functionally different. Moreover, available studies of emotion conflict did not separate emotion-label words and emotion-laden words, but mounting evidence confirms that the two types of emotion words are different (Zhang et al. 2017, 2018a, b). Therefore, the present study aimed to compare emotion-label words and emotion-laden words in emotion conflict.

Method

Participants

After excluding one participant who had exceedingly high artifact violation, 21 participants (8 males, age: 25.63 years on average, SD = 3.83) finished the current experiment. They received 7.45 dollars per hour or course credit in compensation for their participation. We used G*power (Faul et al. 2007) to determine the sample size and found that under conditions where effect size is medium (i.e., partial $\eta^2 = 0.1$) and power is 0.8, using repeated measures ANOVA would require at least 20 participants, namely critical $F(1, 19) = 4.38$, $p = 0.05$. All of the participants were Chinese native speakers without psychiatric disorders and with normal or corrected-to-normal vision.

Stimuli

Altogether, six Chinese negative emotion-label words, 嫉妒 'jealous', 犹豫 'hesitation', 恐惧 'fear', 心酸 'sorrow', 愁苦 'distress', and 愤怒 'anger', six Chinese negative emotion-laden words, 拐卖 'kidnap', 僵尸 'zombie', 奸商 'profiteer', 绑架 'abduction', 叛徒 'traitor', and 棺材 'coffin', six Chinese positive emotion-label words, 痛快 'piquancy', 欣喜 'delight', 快活 'happiness', 乐意 'willingness', 舒心 'pleasure', and 舒坦 'comfort', and six Chinese positive emotion-laden words, 拥抱 'hug', 亲友 'relatives and friends', 喝彩 'applaud', 利润 'benefit', 星空 'starry sky', and 皇冠 'crown', were selected as critical words. As shown in Table 1, the four types of words were matched on word frequency, retrieved from SUBTLEX-CH (Cai and Brysbaert 2010), $F(3, 20) = 0.081$, $p = 0.98$, strokes, $F(3, 20) = 0.815$, $p = 0.5$, and arousal, retrieved from a previous study (Zhang et al. 2017), $F(3, 20) = 0.812$, $p = 0.5$. Valence (Zhang et al. 2017) was confirmed by the fact that positive words were rated as more positive than negative words, $F(3, 20) = 269.184$, $p < 0.001$. Meanwhile, emotion-laden words and emotion-label words were not significantly different in valence, $ps > 0.5$.

Procedure

Participants were seated in a sound-attenuated room at a 70 cm distance from the screen. We adopted a flanker task that required the participants to judge the valence of the target word presented in the center of the screen by pressing the corresponding buttons. The target word was vertically surrounded by the words at upper and lower sites that could be the same (i.e., congruent condition) or different (i.e., incongruent condition) in valence. For example, 愁苦 *chóukǔ* 'sorrow' could be accompanied by 愤怒 *fènnù* 'anger' or 欣喜 *xīnxǐ* 'joy'. It was also worth noting that emotion-label words were only presented with emotion-label words, and the similarly for emotion-laden words. In addition, the words did not always appear with the same words. In this approach, one word could be included in 10 pairs by combining the other 5 words from the same type and randomly selecting 5 words from the opposite valence group with a unique combination for each word. In total, there were 240 trials divided into three blocks (80 trials in each block). Within one trial, participants were presented a fixation for 500 ms, and then the fixation was replaced by the target word vertically surrounded by words with the same or different valence. The participants were instructed to decide the valence of the target (i.e., central) words and ignore the distractors as fast and accurately as possible. At the end of each trial, a word "blink" appeared on the screen for 1000 ms, suggesting that participants could blink if needed. To obtain enough trials (60 trials in each condition) for ERP component analysis, the participants were instructed to continue to finish another three blocks with a different sequence and the same materials. The blocks and trials within one block

Table 1 Word stimuli characteristics ($M \pm SD$)

	Word frequency	Strokes	Arousal	Valence
Negative emotion-label	2.21 ± 1.22	19.33 ± 2.42	4.89 ± 0.10	2.50 ± 0.24
Negative emotion-laden	2.22 ± 1.00	17.83 ± 1.17	4.80 ± 0.11	2.26 ± 0.30
Positive emotion-label	2.06 ± 0.69	18.17 ± 1.83	4.87 ± 0.10	5.33 ± 0.13
Positive emotion-laden	2.26 ± 0.44	17.33 ± 3.27	4.83 ± 1.22	5.08 ± 0.28

were always randomly sequenced. Between the blocks, the participants could have a short rest. The whole experiment lasted roughly 1 h.

EEG recording and data analysis

The electroencephalogram (EEG) data were recorded from a Hydro Cel Geodesic Senor Net with 129 scalp sites (Electrical Goedesics, Inc. EGI: Eugene, OR). The sampling rate was 1000 Hz and impendence of the electrodes was controlled below 50 kΩ during the recording. The offline data were further processed by Net Station Waveform Tools and were initially filtered by a bandpass of 0.1–30 Hz. The continuous data were segmented into 900 ms epochs with 100 ms epochs before stimulus onset as a baseline for correction. Automatic rejection criteria were used to label violated segments. Voltage variations larger than 70 µV were regarded as eye blinks and amplitude changes exceeding 27.5 µV were labeled eye movement. Artifact detection was also performed manually and trials with more than 10% bad channels were excluded from further analysis. The average was computed for each condition across participants.

By visual inspection, we identified N200 (frontal sites: F5/F6, F7/F8, F9/F10, FT7/FT8, FT9/FT10, and AF7/AF8) that is related to emotion and conflict processing (Kanske and Kotz 2010, 2011a). The ERP component was within the time windows of 150–270 ms (N200). Repeated-measures ANOVAs were performed with word type (emotion-label words and emotion-laden words), valence (negative and positive), congruency (congruent and incongruent), electrode, and hemisphere as within-subject factors (electrode and hemisphere were only for ERP data).

Table 2 Descriptive statistics for valence evaluation reaction times (ms) and accuracy rate (% in blanket)

	Congruent	Incongruent	Interference
Negative emotion-label	739.49 (97.62)	797.03 (94.70)	57.54 (2.92)
Negative emotion-laden	703.51 (99.39)	755.59 (97.72)	52.08 (1.67)
Positive emotion-label	705.61 (97.15)	733.90 (95.02)	28.29 (2.13)
Positive emotion-laden	717.11 (97.11)	743.84 (93.89)	26.73 (3.22)

Result

Behavioral data

Responses that were longer than 2540.44 ms (> 2.50 SD) were excluded from further analysis, thereby eliminating 1.72% of the data (see Table 2 for descriptive statistics).

For accuracy rate, a strong main effect of congruency was found, $F(1, 20) = 29.76$, $p < 0.001$, partial $\eta^2 = 0.60$. Specifically, a higher accuracy rate was found for the congruent condition than the incongruent condition. We also found a three-way interaction among word type, valence, and congruency for accuracy rate, $F(1, 20) = 4.64$, $p = 0.044$, partial $\eta^2 = 0.19$, such that negative emotion-laden words had a higher accuracy rate than negative emotion-label words both in incongruent and congruent conditions, $t(20) = 4.11$, $p = 0.001$, $t(20) = 4.10$, $p = 0.001$, but this was not the case for positive words, $ps > 0.1$. More importantly, all of the four types of emotion words generated incongruent effects, $t(20) = 3.75$, $p < 0.01$ for negative emotion-label words, $t(20) = 3.51$, $p < 0.01$ for negative emotion-laden words, $t(20) = 2.80$, $p < 0.05$ for positive emotion-label words, and $t(20) = 3.15$, $p < 0.01$ for positive emotion-laden words. No other main effects or interactions were found in accuracy rate (see Table 2 for more details).

For reaction times, processing speed was slower in the incongruent condition than in the congruent condition, $F(1, 20) = 116.41$, $p < 0.001$, partial $\eta^2 = 0.85$. In addition, the main effect of word type was observed $F(1, 20) = 15.48$, $p = 0.001$, partial $\eta^2 = 0.44$, such that emotion-laden words were processed faster than emotion-label words. There was a strong interaction between word type and valence, $F(1, 20) = 10.56$, $p = 0.004$, partial $\eta^2 = 0.36$. Post hoc comparison showed that emotion-laden words were processed faster than emotion-label words, $t(20) = 4.50$, $p < 0.001$, in the case of negative words, but no difference was observed for positive words, $t(20) = 1.32$, $p = 0.20$. Moreover, an interaction between valence and congruency was found, $F(1, 20) = 9.77$, $p = 0.005$, partial $\eta^2 = 0.33$. Post hoc comparison further revealed that negative words had higher reaction times than positive words in the incongruent condition, $t(20) = 2.78$, $p = 0.012$, but not in the congruent condition, $t(20) < 1$. More importantly, both negative words and positive words produced significant incongruent effects, $t(20) = 11.08$, $p < 0.001$ for negative, $t(20) = 4.15$, $p < 0.01$ for positive. In addition, the incongruent effect of negative emotion words was larger than that of positive emotion words, $t(20) = 3.13$, $p = 0.005$.

ERP data

We found an interaction between word type, valence, and hemisphere, $F(1, 20) = 9.74$, $p = 0.005$, partial $\eta^2 = 0.33$. Post hoc comparison showed that negative emotion-label words (0.59 μV, SD: 1.65 μV) elicited smaller amplitude than negative emotion-laden words (0.99 μV, SD: 1.49 μV) on the left hemisphere, $t(20)=2.44$, $p=0.02$, whereas smaller amplitude was found for positive emotion-label (1.08 μV, SD: 3.08 μV) words than for positive emotion-laden words (1.53 μV, SD: 3.33 μV) on the right hemisphere, $t(20)=2.33$, $p=0.03$. However, no other further comparisons showed differences, $ts<1$. More importantly, there was an interaction between word type, congruency, and hemisphere, $F(1, 20)=4.55$, $p=0.048$, partial $\eta^2=0.19$. Post-hoc comparison showed that emotion-laden words elicited smaller amplitude in the congruent condition (0.60 μV, SD: 1.78 μV) than in the incongruent condition (1.10 μV, SD: 1.44 μV) only on the left hemisphere, $t(20)=2.76$, $p=0.01$, while no difference between the incongruent and congruent conditions was observed for emotion-label words (0.75 μV, SD: 1.45 μV and 0.73 μV, SD: 1.60 μV), $t(20)<1$. Further comparisons also revealed that under the incongruent condition, emotion-label words elicited smaller cortical activation than emotion-laden words only on the left hemisphere (0.75 μV, SD: 1.45 μV and 1.10 μV, SD: 1.44 μV), $t(20)=2.26$, $p=0.04$, whereas no difference was found on the right hemisphere (1.31 μV, SD: 3.29 μV for emotion-label words, and 1.33 μV, SD: 3.16 μV for emotion-laden words), $t(20)<1$ (see Fig. 1).

Discussion

The primary goal of the present study was to compare emotion-label words with emotion-laden words in emotion conflict. The results substantially confirmed the distinction between the two types of emotion words in emotion conflict.

Behavioral results showed that emotion-laden words had a processing advantage over emotion-label words, as negative emotion-laden words showed higher processing speed, a result contrasting with the findings of Kazanas and Altarriba that emotion-label words were processed faster than emotion-laden words. The inconsistency might stem from the differences in the tasks. Kazanas and Altarriba used a lexical decision task (LDT), while the evaluation of valence was required in the present study. It is possible that negative emotion-label words were more difficult for valence evaluation, because negative words are more discrete in nature and the discrete representation made it harder to yield a single valence (Lench et al. 2011, 2013). However, negative emotion-laden words could activate ambiguous negative feelings by connecting to several negative emotion-label words, thereby facilitating the valence evaluation process.

Another finding in behavioral results is that incongruent effect of negative words (55 ms) is larger than that of positive words (28 ms), suggesting that positive words produced larger interference than negative words as flankers. In specific, judging negative target words that are surrounded by positive words made participants hard to inhibit the unrelated positive words whereas negative words as flankers produced significant but smaller interference than positive words, implying that negative words are relatively easier to ignore in valence evaluation. Possibly, negative words are discrete while positive words are merged; therefore, positive words are easier for participants to evaluate the valence than negative words and in turn make larger interference than negative words. What is worth noting is that Zinchenko et al. (2015, 2017) found smaller interference of negative stimuli (32 ms) than positive stimuli (49 ms) in two studies. The discrepancy between the current study and studies of Zinchenko et al. is that we used only visual words and differentiated two kinds of emotion words, whereas Zinchenko et al. used multisensory video stimuli that engage different modulations, which might result in different interference for negative and positive stimuli.

ERP data showed that negative emotion-label words evoked more enhanced N200 than negative emotion-laden words on the left hemisphere, whereas a similar difference was found for positive emotion-label words and positive emotion-laden words on the right hemisphere. These results are inconsistent with the valence hypothesis that negative emotion is dominant on the right hemisphere while positive emotion is more detectable on the left hemisphere (Alfano and Cimino 2008). This is probably due to the fact that we did not find the main effect of valence on N200 and a difference between the two hemispheres. Instead, significant differences between emotion-label words and emotion-laden words were observed for positive words and negative words on different hemispheres. Note that emotion-label words had higher emotion activation than emotion-laden words (Kazanas and Altarriba 2015; Zhang et al. 2017). Therefore, emotion-label words showed enhanced N200 and advantage in conflict processing than emotion-laden words, as supported by the finding that larger N200 was found for emotion-label words than emotion-laden words in the incongruent condition on the left hemisphere, where conflict processing was targeted (Huster et al. 2010). However, it is unclear why negative emotion-label words elicited greater N200 than did negative emotion-laden words on the left hemisphere, while the difference for positive words was found on the right hemisphere. Conceivably, since negative emotion words had a larger interference than positive emotion words, and conflict-related N200 was noticeable on the left anterior region (Huster et al. 2010), negative emotion-label words elicited larger N200 than emotion-laden words probably due to larger interference than for positive words and a superior conflict resolution ability for emotion-label words than for emotion-laden words, at least for negative ones. In addition, positive emotion-label words elicited larger N200 than positive emotion-laden words, probably due to the constrained interference for positive words and larger emotion activation on the right hemisphere (Smith and Bulman-Fleming 2005).

It was also worth noting that emotion word type modulated congruency, such that emotion-laden words elicited a larger N200 in the congruent condition than in the incongruent condition; however, emotion-label words provoked a similar N200 in the two conditions. These results were not in agreement with the previous studies that consistently showed a larger N200 for the incongruent condition than for the congruent condition (Kanske and Kotz 2010, 2011a; Zinchenko et al. 2015, 2017). It is plausible that in emotion conflict, emotion-laden words enlarged the conflict with decreased N200 in incongruent trials, due to the possibility that emotion-laden words were aggregately represented while the emotion-label words, at least negative ones, were discretely represented and accompanied by less conflict than emotion-laden words. However, this novel finding needs further investigation and also suggests that N200 is not always larger in the incongruent condition than in the congruent condition and indeed might be convertible. Future studies could further compare emotion-label words and emotion-laden words in cognitive conflict and emotion conflict to examine how N200 is modulated by the two kinds of words.

Despite accumulated evidence indicating that emotion-label words and emotion-laden words undergo different cognitive processing and have distinct neural correlates (Zhang et al. 2017), there is a lack of a theoretical account of such a distinction. A systematic explanation of the asymmetry in processing speeds for positive and negative stimuli, namely the density hypothesis (Unkelbach et al. 2008), provides an explanation of the distinction between emotion-laden words and emotion-label words. The hypothesis initially was proposed to explain processing advantages for positive information over negative information. The density hypothesis suggests positive information is stored more densely than negative information, and consequently positive stimuli (e.g., words) were processed faster than negative ones (Unkelbach et al. 2008). However, the density hypothesis did not separate emotion-label words from emotion-laden words. Based on the robust findings confirming the distinction between the two kinds of emotion words (Altarriba and Basnight-Brown 2011; Kazanas and Altarriba 2015, 2016; Knickerbocker and Altarriba 2013; Zhang et al. 2017, 2018a, b), we would extend the density hypothesis to take such a distinction into consideration. Specifically, positive emotion-label words and positive emotion-laden words would have similar processing speeds because positive emotion words are clustered. However, negative emotion-laden words would have shorter reaction times than negative emotion-label words, because negative emotion-label words are discrete and surrounded by negative emotion-laden words that have unpredictable and multiple connections to many negative emotion-laden words. Emotion-label words also activate stronger emotion than emotion-laden words do because the emotion-label words connect directly to affective states, while the connection is indirect for emotion-laden words (Knickerbocker et al. 2015). Nevertheless, this account is primitive as the present study only examined 24 emotion words, so future research could examine this explanation further.

Based on the primitive findings of the present study, several other future research directions may be identified. First, although the claim of distinct modulations of emotion-label words and emotion-laden words on emotion conflict processing has been supported, we only examined first language (L1) words; therefore, it remains unclear whether emotion words in a second language (L2) could also influence emotion conflict or whether L2 emotion word types could modulate emotion conflict in different ways. Second, from a developmental perspective, it is also worth examining whether the emotion word type effect is found among children with different reading abilities. This line of research would interrelate reading development, emotion development, and executive function development and provide a holistic picture of how children learn to read, perceive emotion, and resolve conflict processing. Third, it is also worth mentioning that the words used in the present study were somewhat different from previous studies (Alguacil et al. 2013; Kanske and Kotz 2010), not only in differentiating emotion-label words and emotion-laden words, but also in word selection. For example, "piquancy" was a low frequency word in English, while in Chinese the word is of a relatively high frequency. Therefore, cultural differences and word selection (i.e., stimuli list construction) could be further investigated in the future.

In conclusion, the present study demonstrated emotion-label words and emotion-laden words were processed differently in emotion conflict. Behavioral results firstly showed that negative emotion-laden words had advantage over emotion-label words in valence evaluation with enhanced accuracy rate and processing speed, suggesting that negative emotion-label words are discrete whereas negative emotion-laden words are clustered. ERP results further revealed superiority of early emotion activation induced by emotion-label words over emotion-laden words with increased N200. These findings shed light on the configuration of emotions and different roles of emotion-label words and emotion-laden words in constructing the configuration of emotions.

Acknowledgements This study was supported by research Grants MYRG2017-00217-FED, MYRG2016-00193-FED, and MYRG2015-00221-FED Grants from the University of Macau. The authors would thank Kai Chen for his assistance on programming and data collection.

References

Alfano KM, Cimino CR (2008) Alteration of expected hemispheric asymmetries: valence and arousal effects in neuropsychological models of emotion. Brain Cogn 66(3):213–220

Alguacil S, Tudela P, Ruz M (2013) Cognitive and affective control in a flanker word task: common and dissociable brain mechanisms. Neuropsychologia 51(9):1663–1672

Altarriba J, Basnight-Brown DM (2011) The representation of emotion vs. emotion-laden words in English and Spanish in the Affective Simon Task. Int J Biling 15(3):310–328

Botvinick MM, Braver TS, Barch DM, Carter CS, Cohen JD (2001) Conflict monitoring and cognitive control. Psychol Rev 108(3):624

Cai Q, Brysbaert M (2010) SUBTLEX-CH: chinese word and character frequencies based on film subtitles. PLoS One 5(6):e10729

Citron FM (2012) Neural correlates of written emotion word processing: a review of recent electrophysiological and hemodynamic neuroimaging studies. Brain Lang 122(3):211–226

Dolcos F, Iordan AD, Dolcos S (2011) Neural correlates of emotion–cognition interactions: a review of evidence from brain imaging investigations. J Cogn Psychol 23(6):669–694

Egner T, Etkin A, Gale S, Hirsch J (2007) Dissociable neural systems resolve conflict from emotional versus nonemotional distracters. Cereb Cortex 18(6):1475–1484

Faul F, Erdfelder E, Lang A-G, Buchner A (2007) G* Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods 39(2):175–191

Frühholz S, Jellinghaus A, Herrmann M (2011) Time course of implicit processing and explicit processing of emotional faces and emotional words. Biol Psychol 87(2):265–274

Huster R, Westerhausen R, Pantev C, Konrad C (2010) The role of the cingulate cortex as neural generator of the N200 and P300 in a tactile response inhibition task. Hum Brain Mapp 31(8):1260–1271

Kanske P (2012) On the influence of emotion on conflict processing. Front Integr Neurosci 6:42

Kanske P, Kotz SA (2010) Modulation of early conflict processing: N200 responses to emotional words in a flanker task. Neuropsychologia 48(12):3661–3664

Kanske P, Kotz SA (2011a) Conflict processing is modulated by positive emotion: ERP data from a flanker task. Behav Brain Res 219(2):382–386

Kanske P, Kotz SA (2011b) Emotion triggers executive attention: anterior cingulate cortex and amygdala responses to emotional words in a conflict task. Hum Brain Mapp 32(2):198–208

Kazanas SA, Altarriba J (2015) The automatic activation of emotion and emotion-laden words: evidence from a masked and unmasked priming paradigm. Am J Psychol 128(3):323–336

Kazanas SA, Altarriba J (2016) Emotion word type and affective valence priming at a long stimulus onset asynchrony. Lang Speech 59(3):339–352

Knickerbocker H, Altarriba J (2013) Differential repetition blindness with emotion and emotion-laden word types. Vis Cogn 21(5):599–627

Knickerbocker H, Johnson RL, Altarriba J (2015) Emotion effects during reading: influence of an emotion target word on eye movements and processing. Cogn Emot 29(5):784–806

Lench HC, Flores SA, Bench SW (2011) Discrete emotions predict changes in cognition, judgment, experience, behavior, and physiology: a meta-analysis of experimental emotion elicitations. Psychol Bull 137(5):834

Lench H, Bench S, Flores S (2013) Searching for evidence, not a war: reply to lindquist, siegel, quigley, and barrett. Psychol Bull 139(1):264–268

Ma J, Liu C, Chen X (2016) Emotional modulation of conflict processing in the affective domain: evidence from event-related potentials and event-related spectral perturbation analysis. Sci Rep 6:31278

Posner MI, Rueda MR, Kanske P (2007) Probing the mechanisms of attention. In: Cacioppo J, Tassinary L (eds) Handbook of psychophysiology. Cambridge University Press, pp 410–432

Smith SD, Bulman-Fleming MB (2005) An examination of the right-hemisphere hypothesis of the lateralization of emotion. Brain Cogn 57(2):210–213

Soutschek A, Schubert T (2013) Domain-specific control mechanisms for emotional and nonemotional conflict processing. Cognition 126(2):234–245

Unkelbach C, Fiedler K, Bayer M, Stegmüller M, Danner D (2008) Why positive information is processed faster: the density hypothesis. J Pers Soc Psychol 95(1):36

Van Veen V, Carter CS (2002) The anterior cingulate as a conflict monitor: FMRI and ERP studies. Physiol Behav 77(4–5):477–482

Wang X, Shangguan C, Lu J (2019) Time course of emotion effects during emotion-label and emotion-laden word processing. Neurosci Lett 699:1–7

Zhang J, Wu C, Meng Y, Yuan Z (2017) Different neural correlates of emotion-label words and emotion-laden words: an ERP study. Front Hum Neurosci 11:455. https://doi.org/10.3389/fnhum.2017.00455

Zhang J, Teo T, Wu C (2018a) Emotion words modulate early conflict processing in a flanker task: differentiating emotion-label words and emotion-laden words in second language. Lang Speech. https://doi.org/10.1177/0023830918807509

Zhang J, Wu C, Yuan Z, Meng Y (2018b) Different early and late processing of emotion-label words and emotion-laden words in second language: an ERP study. Second Lang Res. https://doi.org/10.1177/0267658318804850

Zinchenko A, Kanske P, Obermeier C, Schröger E, Kotz SA (2015) Emotion and goal-directed behavior: ERP evidence on cognitive and emotional conflict. Soc Cogn Affect Neurosci 10(11):1577–1587

Zinchenko A, Obermeier C, Kanske P, Schröger E, Kotz SA (2017) Positive emotion impedes emotional but not cognitive conflict processing. Cogn Affect Behav Neurosci 17(3):665–677

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.