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競爭可好可壞：正負向情緒詞處理機制之差異

Competition Makes You Better or Worse: Different Processing for Positive and Negative Emotional Words.

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經本委員會審議，符合碩士學位標準，特此證明。

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拖了很久的一段時間，我總算是願意開始寫致謝的內容了。在接近七月底的這一天，又是一個在打著 galgame 和暗黑破壞神的夜晚（馬的 Blizzard 你到底要不要出三代啊你！），我依然在考慮著打完這一章後要開始認真的感謝人，還是接著消化今天的動畫清單，但這時耳機適時的傳來 Pain of Salvation 的歌曲—Morning On Earth，聽著那哀怨不已的歌聲，我很清楚，再不做些什麼明天早上我又得再次迎接嶄新、但一點生命力都沒有，充滿恐懼及懊悔的晨曦了。但那始終困擾著我的問題還是存在，要感謝的人太多了，但我死都不要只是謝天就了事！總之，我決定要學以致用，統計學中有個假設，我們可以藉由抽取一些具代表性的樣本來類推到整個母群，所以我就謝謝一些代表性的人物，要是接下來沒被我寫到的人，就自己推論自己是否在這個母群之中吧！

不知從小時候的哪一天開始，我知道了自己名字的意涵，那是父親的期待，是我們整個家族的遺憾，是一個過去時代所遺留下來的眼淚。從父親往前算起的日子，我們世世代代都是窮苦的農家子弟，父親是個勤學的人，但也敵不過農家小孩讀那麼多書幹嘛的氛圍，只能默默的將夢想交付給下一代的孩子，但我只要一碰上到大考，在人生關鍵的分岔路口時總是會莫名的大病一場，從國中畢業開始算起的連續七年間，我總是認為自己就是個受到家族詛咒的孩子，直到進入台大心理所，父親對我的一句「恭喜，終結自己那不堪命運說」的那一刻起，我那憋了好幾年的淚水終於崩堤了。我要謝謝我父親在我求學之路上的支持與鼓勵，沒有你我就沒有機會站在這裡，是我們一起打敗這個命運，我要將我得到碩士文憑的榮耀第一個與您一起分享。

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摘要

許多的實驗證據顯示，帶有情緒意涵的刺激可以比中性的刺激進行更有效的處理；例如，正向與負向情緒詞比起中性詞有更好的辨識效果。然而，正負向情緒詞的處理歷程是否有所差別仍未知。我們進行了一系列實驗，以檢驗在單詞呈現和雙詞競爭情境下的正負向情緒詞處理歷程。在實驗一中，我們使用了 Zeelenberg、Wagenmakers 和 Rotteveel（2006）二擇一強迫選擇的字詞辨識作業，但將刺激材料從英文詞彙轉換為中文的雙字詞，成功的複製了他們的結果。在實驗二中，我們將目標呈現階段的單詞改為同時呈現兩個詞（目標詞和競爭詞）。為了得到更純粹的情緒效果，我們在實驗二 a 與實驗二 b 中分別使用正向和負向詞來與中性詞搭配出現在目標畫面。結果發現負向詞相對於中性詞的注意力競爭優勢，而兩個正向詞一起呈現卻有著最差的表現。在實驗三中，我們將所有字詞的情緒類型（負向、正向和中性）放在同一個作業中。類似於實驗二的結果再一次被複製：都是負向詞的配對有著最好的作業表現，然而都是正向詞的配對比起它與中性詞的配對卻有著較差的作業表現。在實驗四中，我們將點偵測作業（dot-probe task）增加到我們的二擇一強迫選擇作業中，藉此了解受試者的注意力分配狀況，結果發現若偵測點出現在負向詞的位置會有較快的反應，顯示注意力的確會轉移到負向目標詞的位置上。總結來說，負向詞會攫取我們的注意力，而正向詞會擴大我們的注意力廣度並增進對整體脈絡的處理效能。但是，正正得負，兩個正向詞反而會相互抵銷彼此的效果。我們認為這種差異可能是來自於正向詞與負向詞有著不同的注意資源分配。

關鍵字：情緒（emotion）、注意力資源（attentional resource）、競爭（competition）。

Competition Makes You Better or Worse: Different Processing for Positive and Negative Emotional Words.

Shuo-Heng Li

Abstract

Mounting evidence has shown that emotion-laden stimuli are processed more efficiently than neutral ones; for example, emotional words (negative and positive) are better identified than neutral words under data-limited conditions. However, it remains unclear whether negative and positive emotional words have the same or different processes. Here we report a series of experiments to examine whether there is a difference in processing emotional words with single words and with two competitive words. In Experiment 1, we replicated Zeelenberg, Wagenmakers, and Rotteveel (2006) 's study by using a two-alternative forced-choice (2AFC) perceptual identification task but changed the stimuli from English words to two-character Chinese words. In Experiment 2, we presented two words (a target word and a competitive word) briefly in the target display to examine the processing of emotional words in the two-competitive-words condition. One positive or negative word was paired with one neutral word in Experiment 2a and 2b, respectively. Results showed a competitive advantage for negative target words. In contrast, positive target words were processed more efficiently when they were paired with a neutral competitive word than a positive competitive word. In Experiment 3, we mixed all types of emotional words (negative, positive, and neutral) in the same experiment. Similar results as in Experiment 2 were found: negative-negative pair had the highest accuracy and positive-positive pair had the lowest accuracy. In Experiment 4, we used a dot-probe task in addition to the original 2AFC task to examine the participants' attentional distribution. Results showed a faster response to the dot-probe when it was presented at the location of the negative word, indicating its enjoyment of more attentional resource. The overall results suggest that while negative words capture attention, positive words expand attentional span and facilitate the whole context. However, sometimes more is less—the effects of two positive words offset each other. The different results of positive and negative emotional words may be caused by different allocation of attentional resources.

***Keywords*: emotion, attentional resource, competition**

Content

Introduction

Emotion affects information processing due to its highly relevance to survival and thus is ecologically important. Earlier studies have shown that emotional stimuli are easier to grasp people's attention than non-emotional stimuli (Macleod, Mathews, & Tata, 1986; Ohman, Flykt, & Esteves, 2001; Yiend, 2010) and that emotion-laden stimuli are processed more efficiently than neutral ones (Kissler, Herbert, Peyk, & Junghofer, 2007; Yiend, 2010; Zeelenberg, Wagenmakers, & Rotteveel, 2006). Since emotion is often related to important decisions relevant to survival (e.g., fear of danger, relax of security, etc.), effective processing of emotional stimuli has an advantage; it prompts us to make appropriate responses more quickly under critical situations and thus increases the chance for survival in the long run.

Earlier studies showed that people are prone to process negative emotions—A phenomenon attributed to “attentional bias” (Macleod, Mathews, & Tata, 1986). For example, compared to neutral stimuli, negative emotional stimuli can be searched more efficiently (Hansen & Hansen, 1988; Ohman, Flykt, & Esteves, 2001; Ohman, Lundqvist, & Esteves, 2001) and a subsequently presented dot probe at their location can be detected faster (Mogg, et al., 2000). Nevertheless, some studies have also suggested that positive emotional stimuli can be processed as efficiently as negative stimuli do (Brosch, Sander, Pourtois, & Scherer, 2008; Calvo & Nummenmaa, 2008; Kissler & Koessler, 2011).

Despite the ability in capturing attention, recent studies indicated that processing emotional stimuli are not automatic, but rather, it requires attention. Pessoa, Padmala and Morland (2005) found in their fMRI data that when emotional stimuli lose their advantage of processing under the situation of limited attentional resources, the amygdala response to emotional stimuli became weakened. Tomasik, Ruthruff, Allen and Lien (2009) used a dual-task paradigm to restrict the central attentional resources, and their results also suggest that emotional processing of faces is not fully automatic but needs attention. Meinhardt and Pekrun (2003) used event-related potentials (ERPs) and showed that the P3 amplitude--which is regarded as the allocation of resources to task-processes--induced by an auditory oddball discrimination task was smaller when participants viewed series of emotional pictures (compared to neutral ones) that drained off task-related attentional resource.

The advantage of emotional stimuli compared to neutral ones is shown to occur at early perceptual encoding level, rather than resulting from response selection bias (Anderson & Phelps, 2001; Zeelenberg, et al., 2006). Zeelenberg, Wagenmakers and Rotteveel (2006) presented a target word for a very brief duration (on an average of

26 ms), followed by a mask, and then a target frame that contained the target word and a foil word. Their participants had to choose the one that they just saw before. They found that both positive and negative words had better recognition accuracy than neutral words. They reasoned that such an emotional-word advantage could be caused either by enhanced perceptual encoding of emotional stimuli or response biases that implicitly directed to emotional words. They tested this difference by using a data-limited method (Norman & Bobrow, 1975) in which stimuli were presented for only a limited time, and then compared the accuracy of different types of emotional target words (positive, neutral, and negative) that were paired with different types of emotional foil words (positive, neutral, and negative). Their results showed that emotional valence of foil words did not affect recognition accuracy of the target words, supporting the perceptual enhancement hypothesis. In addition, ERP studies also indicate larger amplitudes of both positive and negative emotional words, compared to neutral words, from early cortical areas (Kanske & Kotz, 2007; Kissler, et al., 2007; Scott, O'Donnell, Leuthold, & Sereno, 2009). Taken together, these studies suggest an early-enhanced effect of emotional stimuli that leads to an advantage of processing.

Although previous studies have shown advantages of processing emotional stimuli, whether there is a difference in processing positive and negative words still remains elusive. In fact, there are few studies investigating the effect of positive emotional stimuli (Anderson & Phelps, 2001; Ohman, Flykt, et al., 2001; Pessoa, et al., 2005) or comparing the performance difference between positive and negative stimuli. Brain imaging studies have shown that positive and negative emotional stimuli activate different brain areas (Davidson, 2003), which suggest that positive and negative emotional stimuli could have different processing mechanisms. Indeed, some studies found different performance by inducing positive or negative emotional states of the observers by films or music and thus inferred different mechanisms for positive and negative emotional states (Fredrickson & Branigan, 2005; Rowe, Hirsh, & Anderson, 2007). However, other behavioral studies found no difference in performance between positive and negative emotional stimuli (Kissler, et al., 2007; Zeelenberg, et al., 2006).

For those studies that found no difference between positive and negative stimuli (Kissler, et al., 2007; Zeelenberg, et al., 2006), the participants only had to process a single target once at a time for lexical decision or word recognition. However, for those studies that demonstrated a difference between positive and negative stimuli (Hansen & Hansen, 1988; Mogg, et al., 2000; Ohman, Lundqvist, et al., 2001), multiple stimuli were presented in the display simultaneously. We suspect that such multiple-stimuli display may have caused a competition for limited attention resources. Mogg et al. (2000) used a dot-probe task in which two images were presented on the screen and their participants had to do a speeded response to the probe appearing at the location that one of the two images was just presented before. The results showed a shorter probe detection time for negative images, suggesting a competitive advantage for attentional resources of negative stimuli, but not positive ones. Ö hman, Lundqvist and Esteves (2001) used a visual search task also found that both positive and negative face detection in a crowd of neutral faces were significantly faster than neutral faces. However, when participants had to detect a negative face among positive crowds, the reaction time was faster than to detect a positive face among negative crowds. This result may be caused by competition for limited attentional resources of positive and negative stimuli.

We consider the competition of emotional stimuli for limited attentional resources important for the following reason. The biased competition theory (Desimone & Duncan, 1995) states that all images presented on the visual receptive fields would have opportunities to trigger the responses of the visual neurons. However, when there are two or more stimuli dealt by the same neuron or by the same local region of the visual cortex, these stimuli will begin to compete for the same resource. And the results of such competition will be influenced by top-down and bottom-up processing collectively. According to the biased competition theory, the processing of the emotional words in the multiple stimuli situation will compete for the limited attentional resources and finally cause a performance difference between positive and negative stimuli due to their unequal competitive advantage. However, in the single word situation, it is possible that the attentional resource allocates to each emotional word equally to lead to the same performance for positive and negative stimuli. This is simply because there is no competition for attentional resource between positive and negative stimuli.

In this study, we examined whether there is a difference in processing emotional words in the single-word condition (Experiment 1) and in the two-competitive-word condition (Experiment 2, 3 and 4). We adopted the two alternative-forced-choice (2 AFC) task similar to that used in Zeelenberg et al. (2006) by presenting the emotional words very briefly (the data-limited method), and used two-character Chinese words instead of English words. After successfully replicating the results as in Zeelenberg et al. (2006) using Chinese words in Experiment 1, we presented two words (one as the target word and the other as the competitive word) in the target display and then soon masked them in Experiments 2 to 4. There were also two words on the screen at the end of each trial. One was the same as the target word presented before, and the other was a foil word. Participants had to choose one word that they just saw earlier and their response accuracy was recorded. By manipulating the competitive situations of multiple words, we hope to simulate a presentation display that is more close to what is seen in daily life, with more ecological validity and find the difference between positive and negative emotional effect that may be caused by limited attentional resources. Moreover, according to the argument of data-limited information methods and the manipulation of target and foil proposed by Zeelenberg et al., we aim to show that the different processing mechanisms between positive and negative emotion words caused by the competition of limited attentional resource is the enhanced perceptual encoding of emotional word but not response bias. We can also investigate whether different pairing of emotional words (positive-positive, positive-neutral, negative-negative, negative-neutral, neutral-neutral) will lead to different results.

Experiment 1

In order to test our incredulity that whether there is a difference in processing of emotional words in the single-word condition and in the condition of two mutually competitive words, we used the same method as in Zeelenberg et al. (2006). They used English words as stimuli to test that the emotion effect is caused by perceptual enhancement but not response bias. The different stimuli used in our study may cause different results and thus, in Experiment 1, we intended to replicate their study by using Chinese two character words. We predict the same result in this study: Emotional Chinese words also enhance perceptual processing as English words do.

Method

Participants

Thirty undergraduate students at National Taiwan University participated in Experiment 1 for extra course credits. All of them were with normal or corrected-to-normal vision.

Apparatus and Stimuli

E-Prime 1 (Psychological Software Tools) was used to control the experiment on a personal computer with a 19” CRT screen (100-Hz refresh rate). The participants conducted this experiment in a small chamber, with their head fixed at a chin rest at a viewing distance of 50 cm.

All the words were presented in black with a white background (Figure 1). Initially each test trial started with the presentation of a column of minus sign (5.06° × 2.39°) at the center of the screen to serve as a warning sign that prompted the location of the upcoming word for 400 ms. A square (4.49°×2.33°) was then presented at the center for 250ms and it was changed into a thick frame square (4.43°×2.30°) as a cue for the incoming word (3.90° ×2.09°) for 50ms. After the word was presented, a mask (5.06°×2.39°) constituted by four random-stroke patterns immediately covered the word for 300ms. In the final frame, two words—one target and one foil—were presented at either side of the central meridian with equal probability at the eccentricity of 4.56°. This display would stay until the participant made a 2AFC response as to which was the target (e.g., the left word in Figure 1).

----------------------------Insert Figure 1 about here---------------------------

Design

The words used in this study were selected based on the Ministry of Education Word Frequency database in Taiwan. There were 244 words, four was used in the instruction phase (two were assigned randomly as targets and the others were foils), 96 in the practice phase, and 144 in the experimental phase.

There are 2 trials formed by 4 neutral words that randomly used as targets or foils in the instruction phase. In the practice phase, 96 neutral words were divided to two groups, one served as target words and the other as the foils. There was no significant difference in word frequency between these two groups (F(1,94) = 0.023, MSE = 37.467, $p > .88$, $\eta^2 < .0001$). There were 48 trials including 4 blocks of 12 trials each in practice phase. In the experiment phase, each emotional type (negative, neutral and positive) contained 48 words that were chosen from a pre-rating by 30 participants on a valence scale of 1 (most negative) to 7 (most positive) ratings and a arousal scale of 1 (most weak) to 7 (most strong) ratings (Appendix A). The two scales were rated separately. The rating results showed main effects of valence (F(2, 58) = 115.316, MSE = .490, $p < .01$, $\eta^2 = .799$) and arousal (F(2, 58) = 30.149, MSE = .719, $p < .01$, $\eta^2 = .510$). A post hoc Tukey test showed that, the valence scores among negative words, neutral words and positive words were significantly different from each other

((58,3).05 =3.404, *MSE* = 0.490, *C*(.05) = 43.5%) and both positive and negative words had higher arousal rate than neutral ones ((58,3).05 =3.404, *MSE* = 0.717, *C*(.05) = 52.7%). There were no significant differences in word frequency (F(2,94) = .404, *MSE* = 33.471, p = .669, η^2 = .009) with 12 and 62 times per million words and stroke count (F(2,190) = .122, *MSE* = 6.010, p = .885, η^2 = .001) with the stroke count between 4 and 24.

A target from one of the three emotion types (negative, neutral, and positive) was paired with a foil from one of the three categories, giving rise to nine (3 × 3) conditions, with eight target/foil pairs in each condition. We divided each emotional type of words into 6 groups equally. Half of them were used as the target words paired with three emotional types of foil words separately, and the others would be used as foil words paired with three emotional types of target words. When words in a set served as targets, this set paired with negative, positive, and neutral foils. When the same set served as foils, it paired with negative, positive, and neutral targets. Further, to make each word pair with the words from all categories, the six sets of words in each category rotated to serve as targets and foils, rendering six combinations, each being assigned to a group of participants.

Procedure

The experiment consisted of three phases: instruction, practice, and experiment. Each trial began with a row of minus signs arranged vertically as warning signal for 400 ms. An outline square was presented for 250 ms afterwards, followed by a 50 ms cue, and then the target word was presented. Before the experiment, an instruction phase was given during which each word was presented on the screen for 200 ms to familiarize the participant with the task. This was followed by a practice phase in which all word were presented within 20 ms that came from pilot study to maintain at about 75 % accuracy. In the experiment phase the target presentation time was the same as was in the practice phase. It was soon masked for 300ms, and finally entered into the response frame until the participant pressed the key to indicate the target. Participants had to press the ‘‘z’’ key with their left index finger to indicate they thought that the word on the left was the target word, press the ‘‘/’’ key with their right index finger to indicate that the word on the right was the target word.

After completion of the 2AFC task, the participant had to finish the valence ratings for the words used in the experiment using a 1 (very negative) to 7 (very positive) scales. This manipulation check was to ensure that the participants who conducted the experiment rated the three categories of the words (positive, neutral, and negative) similarly as in the pre-rating task which was conducted by another group of participants.

Results and discussion

The ratings of emotion valence were significantly different among the three types of emotional words ($F(2, 58) = 579.328$, MSE =.117, $p < .01$, $\eta^2 = .952$). A post hoc Tukey test showed that, there are significant different among negative words, neutral words and positive words ((58,3).05 =3.404, MSE = 0.117, $C(.05) = 21.3\%$). We conducted a three (target: negative, neutral, or positive) by three (Foil: negative, neutral, or positive) two-way repeated measures analysis of variance (ANOVA). There was a main effect of target type ($F(2, 58) = 4.858$, MSE = .17, $p = .011$, $\eta_p^2 = .143$), but no main effect of foil type ($F(2, 58) = .622$, MSE = .022, $p = .541$, $\eta_p^2 = .021$) and no interaction ($F(4, 116) = 1.268$, MSE = .024, $p = .287$, $\eta_p^2 = .042$). A post hoc Tukey test showed that, the positive and negative emotional target words both had higher accuracies than neutral target words ((58,3).05 =3.404, MSE = 0.016, $C(.05)$, = 5.8%) (Figure 2), and no difference was found for the accuracies between positive and negative emotional target words.

----------------------------Insert Figure 2 about here---------------------------

In Experiment 1, we replicated the work of Zeelenberg et al. (2006) by using Chinese two-character words. We demonstrated that Chinese emotional words that were presented alone also received deeper processing than neutral words, consistent with what was found in the study using English words (Zeelenberg, et al., 2006).

Experiment 2a and 2b

In Experiment 2, we examined whether there is a difference in the processing of positive and negative emotional words under two competitive words. We used the same procedure as in Experiment 1, but presented two words (a real target and a competitive target). We compared positive and neutral words in Experiment 2a, and compared negative and neutral words in Experiment 2b. If the competitive situation is the reason why positive or negative emotional words advantage were discovered, then the different performances in the two tasks should demonstrate the different processing mechanisms for positive and negative words.

Method

Participants

Twenty-eight college students participated in Experiment 2a and 2b respectively for extra course credits. They were recruited from National Taiwan University and all of them have normal or corrected-to-normal vision.

Apparatus and Stimuli

In Experiment 2, two words (one target word and one competitive target word) were presented (Figure 3). The row of minus signs in the warning signal and the mask characters were also changed from one column to two columns accordingly. The outline square and the cue were replaced by a 4.49°×4.66° square and a 4.43°×4.60° square to cover these words. The refresh rate was also changed from 100-Hz to 75-Hz and the two words were presented within 26 ms that came from a pilot study that showed that this was the time for maintaining at about 75 % accuracy.

-----------------------------Insert Figure 3 about here----------------------------

Design

In Experiment 2a and 2b, only positive words and negative words that paired with neutral words were used respectively. In addition, we had already shown that the advantage of emotional words was caused by perceptual enhancement but not response bias, and thus we did not manipulate the emotional type of the foil words in this experiment. Now the target and foil words in the response display were always of the same emotional type.

The number of the word of each emotional type in this experiment was changed from 48 to 64, so there were 292 words, 4 were used in the instruction phase, 96 in the practice phase, and 192 in the experiment phase.

The designs of instruction phase and practice phase were the same as in Experiment 1. In the experiment phase, each emotional type (negative, neutral, and positive) contained 64 words that were chosen from a pre-rating by a valence scale of 1 (most negative) to 7 (most positive) ratings and a arousal scale of 1 (most weak) to 7 (most strong) ratings (Appendix B). There were main effects of emotion category ($F(2, 282) = 127.646$, $MSE = .481$, $p < .01$, $\eta^2 = .815$) and arousal category ($F(2, 58) = 30.329$, $MSE = .773$, $p < .01$, $\eta^2 = .511$). A post hoc Tukey test showed that, there are significant different valence among negative words, neutral words and positive words ((58,3).05 =3.404, $MSE = 0.481$, $C(.05)$, = 43.1%) and both positive and negative words had higher arousal rate than neutral ones ((58,3).05 =3.404, $MSE = 0.773$, $C(.05)$, = 54.7%). There were no significant differences in word frequency ($F(2, 126) = 3.038$, $MSE = 70.162$, $p > .05$, $\eta^2 = .046$) with 12 and 126 times per million words and with the stroke count ($F(2, 254) = .093$, $MSE = 8.744$, $p > .05$, $\eta^2 = .001$) with the stroke count between 3 and 24.

A target from one of the two emotion categories (positive and neutral in 2a, negative and neutral in 2b) was paired with a competitive target from one of the two categories, giving rise to 4 (2 × 2) conditions, with 16 target/ competitive target pairs in each condition. The competitive target words were chosen from the foil words used in Experiment 1. They were presented with equal probability at each side of the vertical meridian, and the competitive words were never the same as the foil words in a trial. We divided each emotional type of words into 4 groups equally. Half of them were used as the target words that were paired with three emotional types of competitive target separately, and the others were used as foil and competitive target words that were paired with three emotional types of target words. Each one of words would be presented twice (at the stimulus and recognition stage). Further, to make each word pair come the words from all categories, the four sets of words in each category rotated to serve as targets and foils, rendering four combinations, each being assigned to a group of participants.

Procedure

The procedure of Experiment 2 was similar to that in Experiment 1, except that but two words (one target and one competitive target) were presented in the stimulus display. There were 64 trials in one block, and the block would repeat four times. There were a total of 256 trials in each of Experiment 2a and 2b.

Results and discussion

In Experiment 2a, the rating scores made by the participants after the experiment were significantly different ($F(2, 54) = 187.037$, $MSE = .288$, $p < .01$, $\eta_p^2 = .874$) among negative words, neutral words, and positive words ((54,3).05 =3.412, MSE = 0.288, C(.05) , = 43.7%). A two (target: positive or neutral) by two (competitive target: positive or neutral) repeated measures ANOVA revealed no main effects of target type ($F(1, 27) = .911$, $MSE = .005$, $p = .348$, $\eta_p^2 = .033$) and competitive target type ($F(1, 27) = 1.227$, $MSE = .004$, $p = .278$, $\eta_p^2 = .043$), but the target by competitive target type interaction was significant ($F(1, 27) = 8.783$, $MSE = .002$, $p < .01$, $\eta_p^2 = .245$). Both positive and neutral target words had higher accuracies when they were under a positive-neutral pair. The positive-positive pair had the lowest accuracy (Figure 4).

In Experiment 2b, We found a statistically significant in emotion valence rating ($F(2, 54) = 211.102$, $MSE = .266$, $p < .01$, $\eta_p^2 = .887$) among negative words, neutral words, and positive words ((54,3).05 =3.412, MSE = 0.333, C(.05) , = 47.0%). A two (target: negative or neutral) by two (competitive target: negative or neutral) two-way repeated measures ANOVA was performed. There was a main effect of target type ($F(1, 27) = 5.37$, $MSE = .002$, $p = .028$, $\eta_p^2 = .166$) but not of competitive target type ($F(1, 27) = .055$, $MSE = .003$, $p = .816$, $\eta_p^2 = .002$), and there was no interaction (F(1,

27) = .349, *MSE* = .002, p = .559, η_p^2 = .013). Negative target words had higher accuracy than neutral target words (Figure 4).

----------------------------Insert Figure 4 about here---------------------------

Taken together, different result patterns were found for positive and negative words when they were paired with neutral words, suggesting possible different processing mechanisms for positive and negative words. In Experiment 2a, both positive and neutral target words led to higher accuracy in the positive-neutral pair compared to the positive-positive pair which had the lowest accuracy. In Experiment 2b, accuracy was higher for negative emotional target words than neutral target words. This result seems to demonstrate that negative emotional words have a competitive advantage of capturing attention (Macleod, et al., 1986). As for positive emotional words, surprisingly, under the condition when both words were positive in emotional valence, performance was worse than when positive target words were paired with neutral words. That means that two positive words will compete with each other and suppress each other, and thus lead to a poorer performance than a positive-neutral pair.

Experiment 3

In Experiment 2, a difference in performance for positive and negative words in the condition of two competitive words was found. However, this result was based on the fact that positive and negative emotional words were paired with neutral words respectively. In order to confirm whether similar results still could be obtained when the positive and negative emotional words were put together, In Experiment 3 we used both positive and negative emotional words in one task. In this case, we expect that the result should be the same as what was found in Experiment 2: The deteriorating effect of double positive words and the facilitation effect of negative words.

Method

Participants

Thirty-six college students participated in Experiment 3 for extra course credits. All of them were recruited from National Taiwan University with normal or corrected-to-normal vision.

Design and Procedure

The procedure of Experiment 3 was similar to Experiment 2, but all the three emotional type (negative, positive, and neutral) were used in the task. The number of the word of each emotional type in this experiment was changed from 64 to 72, so there were 316 words, four was used in the instruction phase, 96 in the practice phase, and 216 in the experimental phase.

The designs of instruction phase and practice phase were the same as Experiment 1 and 2 did. In the experiment phase, each emotional type (negative, neutral and positive) contained 72 words that were chosen from a pre-rating by 30 participants on a valence scale of 1 (most negative) to 7 (most positive) ratings and a arousal scale of 1 (most weak) to 7 (most strong) ratings (Appendix C). There were main effects of emotion category ($F(2, 58) = 135.441$, $MSE = .474$, $p < .01$, $\eta^2 = .824$) and arousal category ($F(2, 58) = 9.961$, $MSE = .647$, $p < .01$, $\eta^2 = .256$). A post hoc Tukey test showed that, there are significant different valence among negative words, neutral words and positive words ((58,3).05 =3.404, $MSE = 0.474$, $C(.05)$, = 53.9%) and both positive and negative words had higher arousal rate than neutral ones ((58,3).05 =3.404, $MSE = 0.647$, $C(.05)$, = 63.0%). There were no significant differences in word frequency ($F(2,142) = 1.295$, $MSE = 68.276$, $p = .277$, $\eta^2 = .018$) with 2 and 126 times per million words and stroke count ($F(2,286) = .296$, $MSE = 9.044$, $p = .744$, η^2

= .02) with the stroke count between 3 and 24.

A target from one of the three emotion types (negative, positive, and neutral) was paired with a competitive target from one of the three categories, giving rise to 9 (3 × 3) conditions, with twelve target/competitive target pairs in each condition. We divided each emotional type of words into 6 groups equally. Half of them were used as the target words that were paired with three emotional types of competitive target separately, and the others were used as foil and competitive target words paired with three emotional types of target words. Further, to make each word pair with the words from all categories, the six sets of words in each category rotated to serve as targets and foils, rendering six combinations, each being assigned to a group of participants.

There were 108 trials in one block, and the block would repeat three times so there were a total of 324 trials for Experiment 3.

Results and discussion

We found a statistically significant in emotion valence rating ($F(2, 70) = 432.785$, $MSE = .222$, $p < .01$, $\eta^2 = .925$) among negative words, neutral words, and positive words ((70,3).05 =3.393, $MSE = 0.222$, $C(.05)$, = 33.5%). A three (target: negative, neutral or positive) by three (competitive target: negative, neutral or positive) two-way repeated measures ANOVA was performed. There was the main effect in target type ($F(2, 70) = 7.078$, $MSE = .006$, $p <.01$, $\eta_p^2 = .168$) but not the main effect of competitive target type ($F(2, 70) = 0.446$, $MSE = .006$, $p = .642$, $\eta_p^2 = .013$). The negative target words had higher accuracy than neutral and positive target words (Figure 5).

We also found the target by competitive target type interaction effect ($F(4, 140) = 4.301$, $MSE = .005$, $p < .01$, $\eta_p^2 = .109$). When the target words were paired with neutral competitive target words, positive target words and negative target words both had higher accuracy than neutral target words ($F(2, 210) = 8.22$, $MSE = .005$, $p < .01$, $\eta_p^2 = .167$). Also, when neutral target words were coupled with positive competitive target words, the accuracy was higher than that when coupled with neutral competitive target words ($F(2, 210) = 3.619$, $MSE = .005$, $p = .03$, $\eta_p^2 = .099$). More importantly, we found negative target words paired with negative words had better performance than neutral and positive target words paired with negative words ($F(2, 210) = 5.223$, $MSE =.005$, $p < .01$, $\eta_p^2 = .132$) and positive target words paired with neutral words had better performance than paired with positive words ($F(2, 210) = 3.779$, $MSE =.005$, $p = .02$, $\eta_p^2 = .091$).

----------------------------Insert Figure 5 about here---------------------------

In Experiment 3, once again, we found that negative emotional target words had better performance than positive and neutral target words. This result demonstrated that the negative emotional words have a competitive advantage of attentional capture. As for positive emotional words, they effectively facilitated the performance of neutral target words that paired with them. It seems to indicate that positive words can broaden the focus of attention (Fredrickson & Branigan, 2005). Moreover, negative target words had the best performance when paired with negative words but not positive and neutral ones. On the contrary, in the condition when both words were positive in emotional valence, worse performance than positive target words paired with neutral words was found again.

Experiment 4

In the above experiments, we found different result patterns for positive and negative emotional words. Kim and Cave (1995) used a dot-probe task to measure the distribution of spatial attention in a visual search task. They asked participants to do a speeded response to the probe after a visual search display and the probe appeared in a position formerly occupied by either the target or a distractor. To examine whether different emotional words have different attentional distributions that lead to different task performances, in Experiment 4, we used the dot-probe task similar to that used in Kim and Cave to explore the participants' attentional distribution in our 2AFC task.

Method

Participants

Thirty college students participated in Experiment 4 for extra credits. They were recruited from National Taiwan University and all of them had normal or corrected-to-normal vision.

Stimuli and Procedure

The procedure of Experiment 4 was identical to that of Experiment 3, except for using a 0.5°×0.5° black dot as the probe in this study (Figure 6). The duration of masking changed from 300ms to 30ms, and the probe would appear 30ms after the mask and 30ms blank, and Participants had to press the space bar if they saw the dot probe as quickly as possible. There was 1500 ms for them to do the probe response, and afterwards they still had to finish the recognition task. The word groups of Experiment 4 used were the same as in Experiment 1, and thus there were 72 trials in one block. Experiment 4 contained four blocks, with a total of 288 trials. Participants had to do the probe detection task in half of trials and didn't have to do any response until the recognition display presented on the other half. The position of the probe appeared at the left or right side was counterbalanced between participants.

-----------------------------Insert Figure 6 about here---------------------------

Results and discussion

We found a statistically significant in emotion valence rating ($F(2, 58) = 455.754$, $MSE = .197$, $p < .01$, $\eta_p^2 = .940$) among negative words, neutral words, and positive words ((58,3).05 =3.404, MSE = 0.197, C(.05) , = 34.8%) In Experiment 4, we conducted a two (target: negative, neutral, or positive) by two (competitive target: negative, neutral, or positive) repeated measures ANOVA. For the correct RTs of probe detection, there was a main effect of target type ($F(2, 58) = 3.944$, MSE = 1221.101, $p = .025$, $\eta_p^2 = .120$). A post hoc Tukey test showed that, the detection time of probe appeared on negative target word position was faster than that appeared on positive and neutral target word positions ((58,3).05 =3.404, MSE = 1221.101, C(.05) , = 15.80%) (Figure 7). There was no effect of competitive target type ($F(2, 58) = .344$, MSE = 1375.19, $p = .711$, $\eta_p^2 = .012$) and no interaction of target by competitive target type (F(4, 116) = .982, MSE = 1587.236, $p = .42$, $\eta_p^2 = .033$).

We also used a 2 (target: negative, neutral or positive) x 2 (competitive target: negative, neutral or positive) ANOVA to analysis accuracy data. There was no main effect of target ($F(2, 58) = .751$, MSE = .008, $p = .476$, $\eta_p^2 = .025$), competitive target ($F(2, 58) = .53$, MSE = .007, $p = .592$, $\eta_p^2 = .018$) and target x competitive target interaction (F(4, 116) = .097, MSE = .006, $p = .983$, $\eta_p^2 = .003$).

----------------------------Insert Figure 7 about here---------------------------

In Experiment 4, the result of the dot-probe task showed that compared to neutral words, the probe that was presented after the negative emotional words took shorter time to detect, indicating that negative emotional words have the advantage of attentional capture. However, we did not find any similar effect in positive emotional words and this may be due to that positive emotional words are non-threatening stimuli and no urgent reaction is required (Brosch, et al., 2008). Moreover, in the recognition task we could not replicate the emotional effects found in Experiment 2 and 3. This may be due to the interference of the dual task paradigm that a shortage of attentional resources occurred and finally caused the emotional effects to disappear (Pessoa, et al., 2005). Furthermore, the time interval from the target display to the response display was probably too long (1.6 seconds) and this may also cause the absence of the emotional effects found in previous experiments.

General discussion

In this study, we showed that there were different task performances between positive and negative words in the condition of two competitive words. In the 2AFC task that we used here, participants had to choose one word that had appeared before. In Experiment 1, we replicated Zeelenberg et al. (2006) 's study that both positive and negative emotional words had better performance than neutral words under the single-word condition. Namely, the effect of enhanced perceptual encoding of emotional words can also be observed with Chinese words. In Experiment 2a and 2b, we used positive words and negative words to pair with neutral words respectively. In Experiment 3, we used all emotional types of words in the same task. In Experiment 2 and Experiment 3, we found different performances for positive and negative emotional words. Negative target words had higher accuracy than neutral target words. Although both positive and neutral target words had higher accuracy in the positive-neutral pairs, paradoxically, the negative-negative pairs led to the best but positive-positive pairs led to the worse performance. In Experiment 4 by using the dot-probe task, we found a shorter detection time of the probe that appeared at the position that negative emotional words just appeared before.

These results suggest that when there were multiple words competing for limited attentional resources, different processing mechanisms are revealed for positive and negative emotional words. Many previous studies showed that emotional stimuli could be processed more quickly (Calvo & Nummenmaa, 2008; Macleod, et al., 1986; Mogg, et al., 2000; Ohman, Flykt, et al., 2001). Theoretically speaking, the rapid processing was influenced by attention, and such effect may disappear under the situation that lacks attentional resources (Pessoa, et al., 2005; Tomasik, et al., 2009). These results can also be found in our Experiment 4. After we added a dot-probe detection task, the emotional effects no longer existed. However, the emotional effects were still there with limited attentional resources as in our Experiments 2 and 3. We can observe that the motional words compete for limited attentional resources with the adjacent word, resulting in a different performance between words of positive and negative emotional type.

Negative words have the advantage in capturing attention. In Experiments 2b and Experiment 3, the results indicated that negative emotional words showed a better performance than positive and neutral words when the attentional resources were limited or scarce. Many studies have also found that negative emotional words had better processing efficiency and it was inferred that the results may be caused by its advantage of attracting attention (Hansen & Hansen, 1988; Macleod, et al., 1986;

Mogg, et al., 2000). This advantage should be related to the specificity of negative stimuli, such as in the phenomenon of weapon-focus (Loftus, Loftus, & Messo, 1987). Negative emotional stimuli are often related to dangerous and negative experiences. In order to avoid the risk of danger, people are inclined to allocate more attentional resources to the negative emotional stimuli and therefore cause the exclusion of other peripheral information. Some researchers also argued that negative emotions narrow the scope of attention (Fredrickson & Branigan, 2005). Our results in Experiment 4 also support the argument that emotional words had the advantage of attentional capture, and enjoyed a faster response to the position of the negative emotional word.

On the contrary, positive emotional words can expand attentional span and facilitate the processing of the whole context. It was found that positive emotion could broaden the scope of attention and the amount of cognitive strategies (Fredrickson & Branigan, 2005; Rowe, Hirsh, & Anderson, 2007). Fredrickson and Branigan (2005) used video films to trigger people's emotion states and found that positive emotion states can increase the scope of attention span and cognitive strategies. Rowe et al.(2007) used music to trigger subjects' emotion states and found similar results. Note that these increases of attentional span were caused by changing participants' emotional states. In our Experiment 2a and 3, the only use of positive words could immediately increase the attentional span. When there were positive emotional words appearing on the screen, the neutral target words' performance was as good as that of positive emotional target words.

The processing of positive word could also be influenced by the adjacent word: Two positive effects counteract each other. In Experiments 2a and 3, the participants had a relatively poor task performance for positive emotional target words when two positive words were presented simultaneously. Why the advantage caused by positive emotional words that can broaden attentional span and strengthen the peripheral stimuli processing disappeared under the positive-positive pairs? Kanske and Kotz (2011) presented multiple positive emotional words simultaneously and participants were asked to judge the color of the central word. Their result showed that even in the condition that the colors of the flanker words and target words were inconsistent; the effect of positive words would moderate the conflicting processing of different colors and led to correct identification of the colors of target words. The facilitation effect of the positive emotional words should not disappear even under the multiple positive words pairs like Kanske and Kotz's study, therefore the worse performance of double positive words can not just attributed to the two-words condition we used here.

One possibility is that positive emotional words have expanded the breadth of the attentional scope; they might be influenced by the peripheral words and therefore resulted in a different task performance. We infer that the worse performance of positive-positive word pairs was caused by the overlapping use of the attentional resource, which led to the competition of the limited attentional resource shared by the two positive emotional words, and such competition caused the relatively low recognition rate in Experiments 2a and 3. That is, the negative effect due to the double positive words we report here is caused by the positive target word competing with adjacent positive word and offset each other. When both adjacent words are neutral or negative, because of their different valences relative to positive emotional target words and therefore will not offset the processing of effect of emotional words. Kanske and Kotz's (2011) results may also be attributed to the different cognitive resource of word and color, thus the positive emotion effect did not disappear. In addition, the results may also be due to the slack of attention caused by the positive words. Positive emotional words make people seeing things in a more relaxed way, so when the positive words are presented on the screen, they may make people feel relaxed and induce the poor processing of semantic information (Brosch, et al., 2008).

Our results indicate that negative and positive emotional words can influence the allocation of attentional resources, thus causing the different performances under multiple-word situation. Because of the narrowing of attention scope, the negative emotional effect would not be influenced by the peripheral words. The narrow scope of attention also causes the narrow area of attentional resources that do not overlap with the area of attentional resources of other words. Therefore, even the negative-negative words pair will not have to compete with each other for the same limited attentional resources and this could enhance both words' perceptual encoding and lead to the best performance among the other word pairs. The positive emotional words have broadened the scope of attention that may also expand the area of attentional resource. As a whole, the words presented on the screen will acquire an enhancement of perceptual encoding. However, the extended region will let positive words be influenced by adjacent words that the results showed the positive words have to compete for the limited resources with the other positive words. It thus leads to a worse performance.

The difference between positive and negative words can also be illustrated by the extent to which attentional resources is concentrated That is, the negative words may highly concentrate attentional focus. Thus, the two negative words in the current study may be processed more efficiently. On the other hand, the positive words may diffuse attentional resources spatially; consequently these words are processed less efficiently.

The emotional stimuli induce different performances under the no-competitive and competitive condition. Zeelenberg et al. (2006) argued that the emotional effects were caused by the enhanced perceptual encoding of emotional stimuli, and this argument is also supported in our Experiment 1. That is, both the positive and negative emotional words were enhanced similarly when only one word was presented where there was no any competition. However, in our Experiments 2 and 3, the effect of emotional words were not only influenced by enhanced perceptual encoding of emotional stimuli but also affected by the limited attentional resource. We believe that this is due to the competitive condition and induce the difference between positive and negative stimuli.

The amount of emotion category can also be the interpretation of the results in this study. The category of negative stimuli were more numerous and complicated than the category of positive stimuli. We believe that under these conditions, thus the negative-negative pair's similarity was lower than positive stimuli, so the discrimination and recognition of negative stimuli were easier. In contrast, positive-positive pair's similarity was relatively higher, leading to relatively poor identification performance. Future experiments should try to manipulate the number of emotional stimulus category and the semantic similarity between them and to see whether recognition of positive and negative stimuli will differ when these factors are equated.

Many recent studies have found the emotional effect was mostly induced by the arousal of emotional intensity but less affected by emotional valence (Kissler, et al., 2007). Our finding indicates that the effect of emotional valence could generate a difference between positive and negative emotional words under the condition with limited attentional resources. We did not explore the arousal of emotional intensity. We predict that the different arousal levels of emotional intensity may lead to different processing efficiency of emotional words. The stronger the stimulus intensity, the more powerful results we will find in this experiment. It is a direction for future research.

The current findings have important implications for in the field of reading and emotion studies. Past studies adopting the priming, lexical decision task (LDT) and recognition tasks used a single word (Kissler, et al., 2007; Tomasik, et al., 2009; Zeelenberg, et al., 2006). Our study used multiple words that would be closer to daily life and gained better ecological validity. By bearing the discovered processing mechanism for the positive and negative words in mind, people can understand the meaning of one sentence or an article efficiently by making the best use of the different advantage of emotional words under various demanding situations. This may improve the efficiency during reading**.** Moreover, the different processing mechanisms of positive and negative emotion stimuli we suggested here can lead to further testing in future work.

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Figures

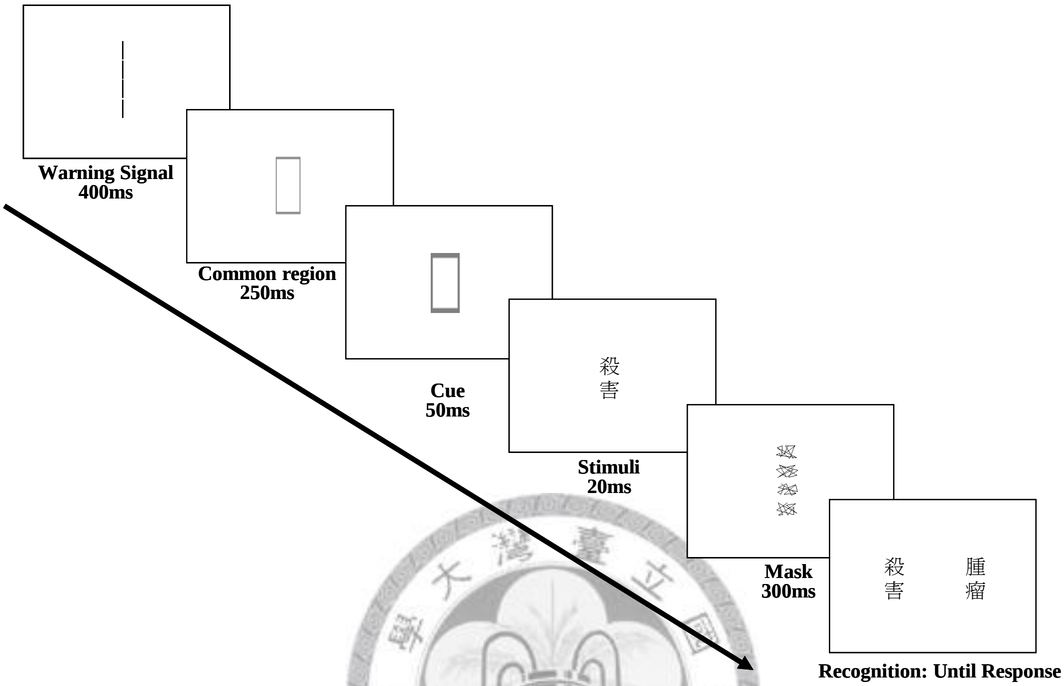


Figure 1. The procedure of the 2AFC task in Experiment 1.

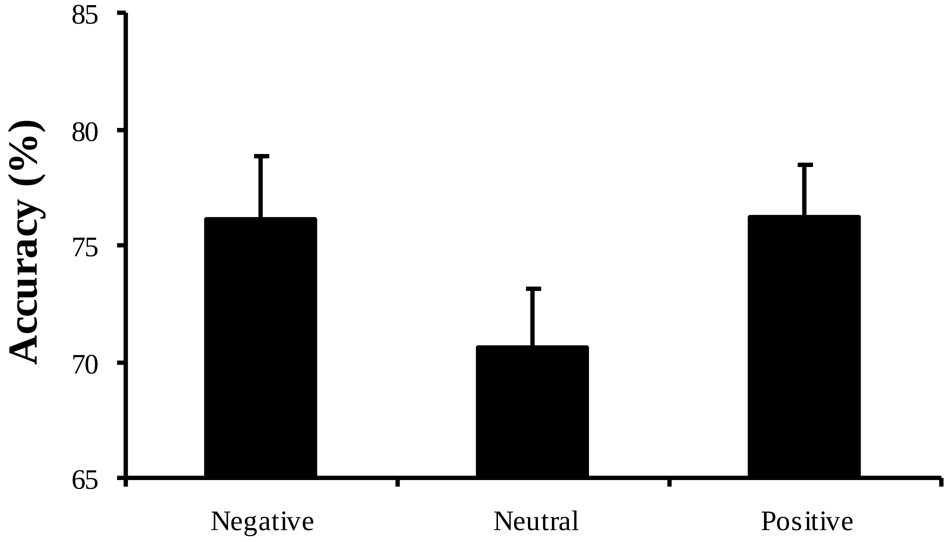


Figure 2. Mean accuracy of target recognition in Experiment 1. Error bars represent standard errors from the mean.

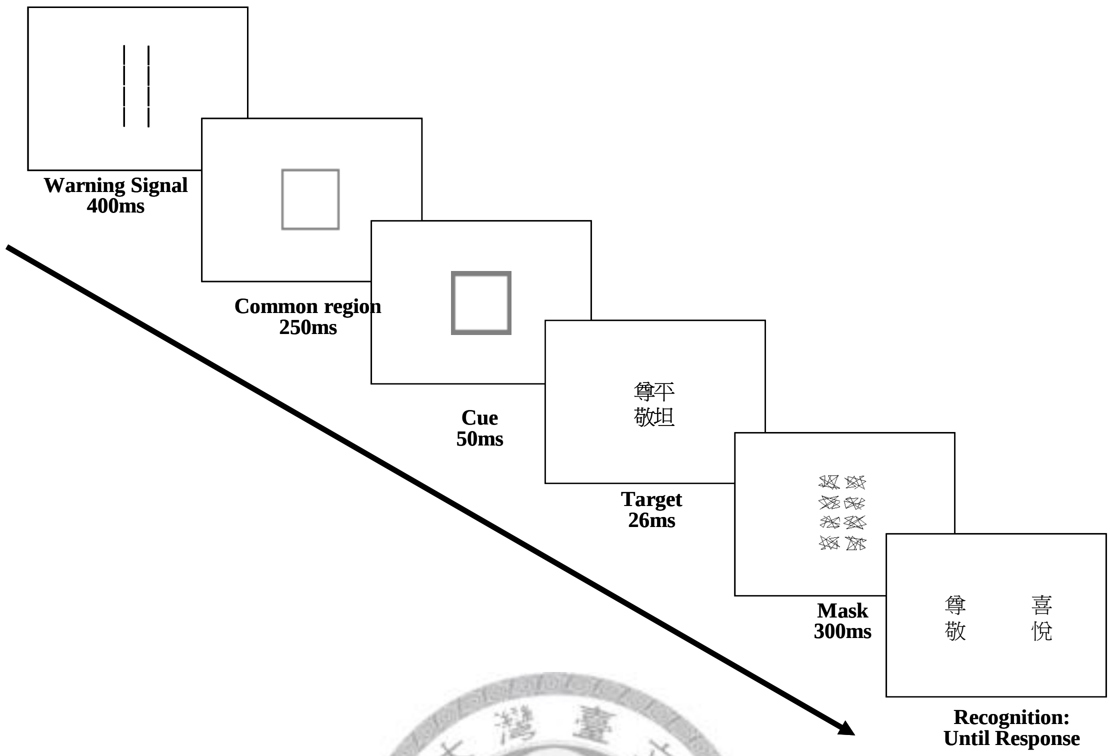
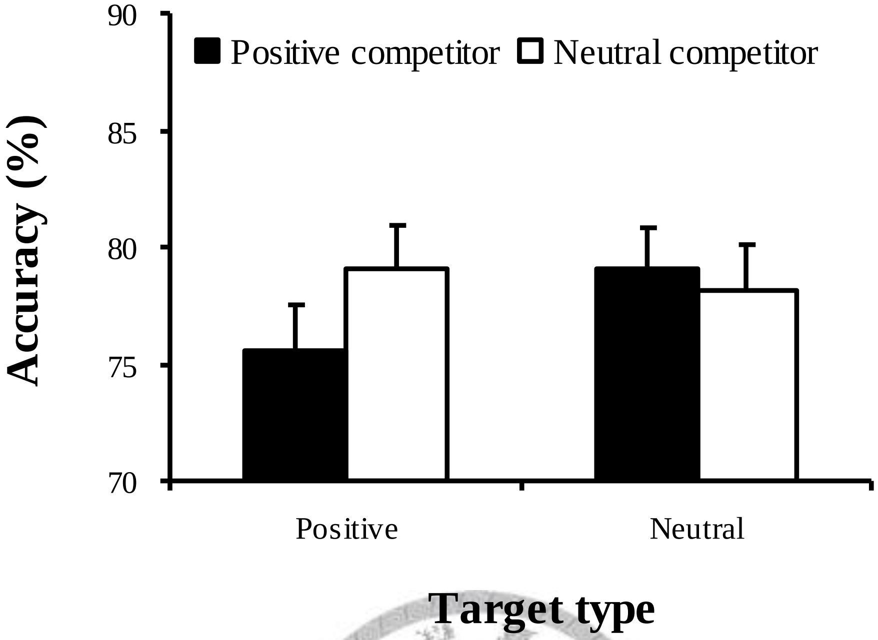


Figure 3. The procedure of the 2AFC task in Experiment 2.

Experiment 2a



Experiment 2b

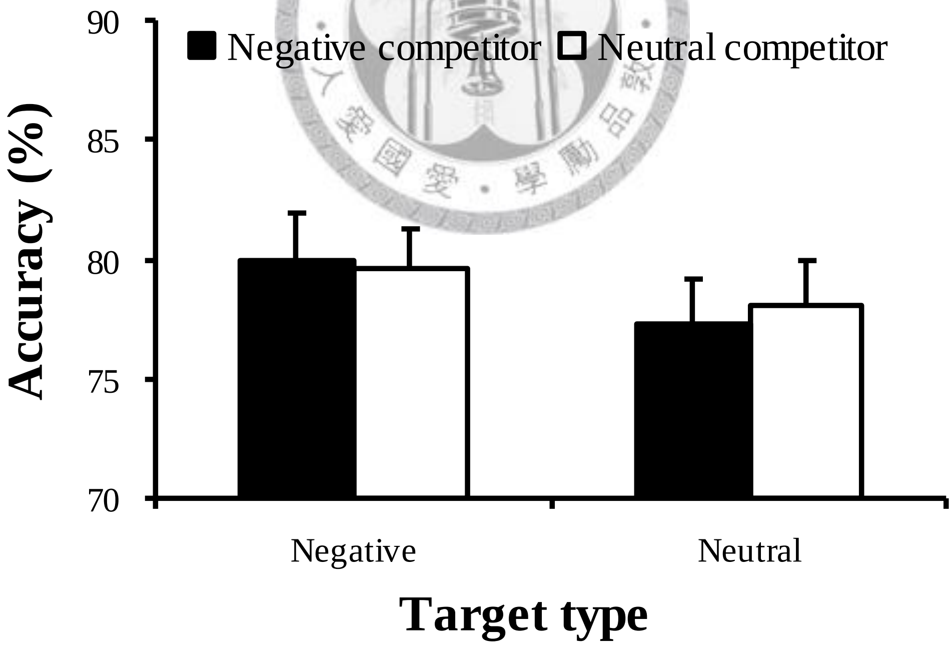


Figure 4. Mean accuracy of target recognition in Experiment 2a and 2b. Error bars represent standard errors from the mean.

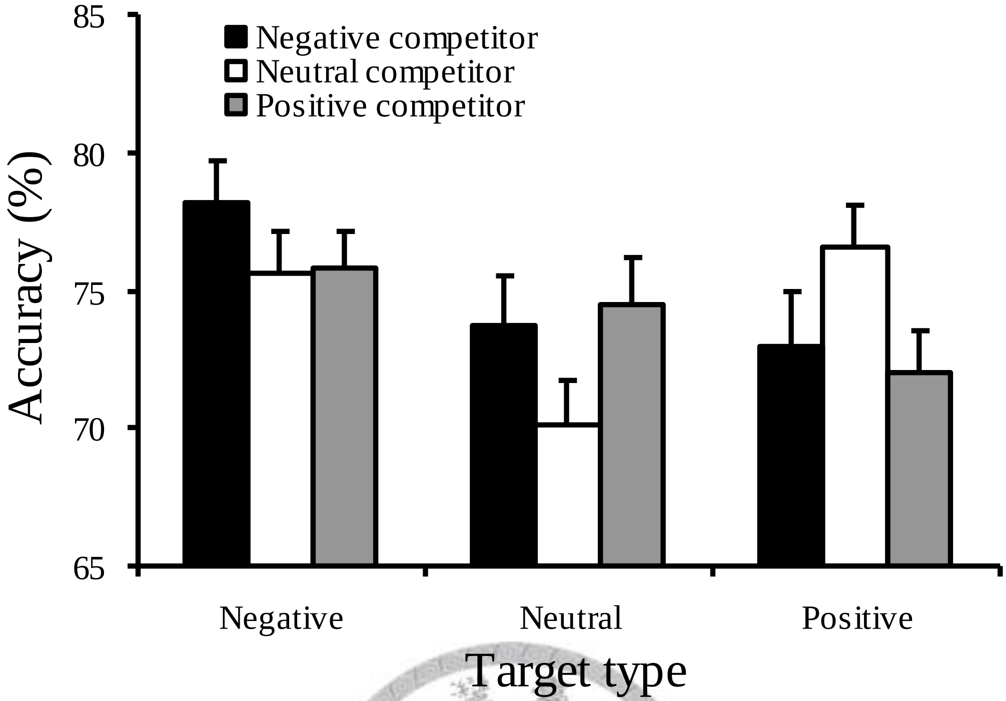


Figure 5. Mean accuracy of target recognition in Experiment 3. Error bars represent standard errors from the mean.

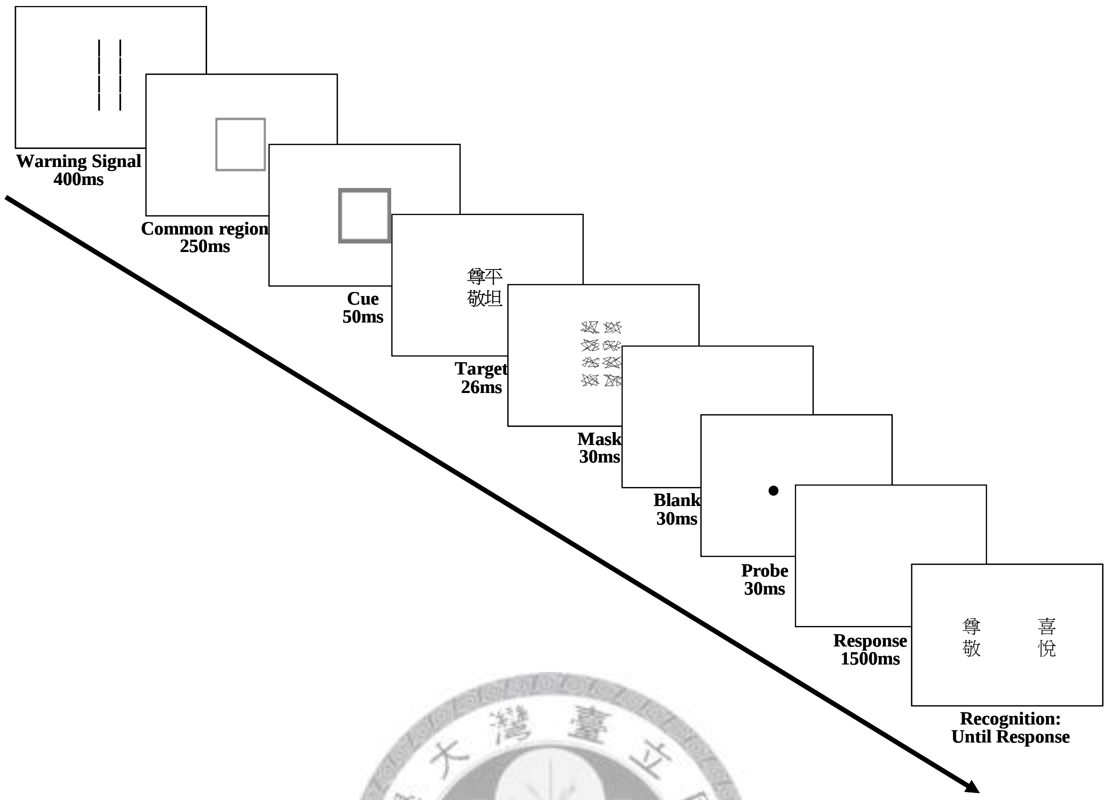


*Figure 6.*The procedure of the dot-probe task and 2AFC task in Experiment 4.

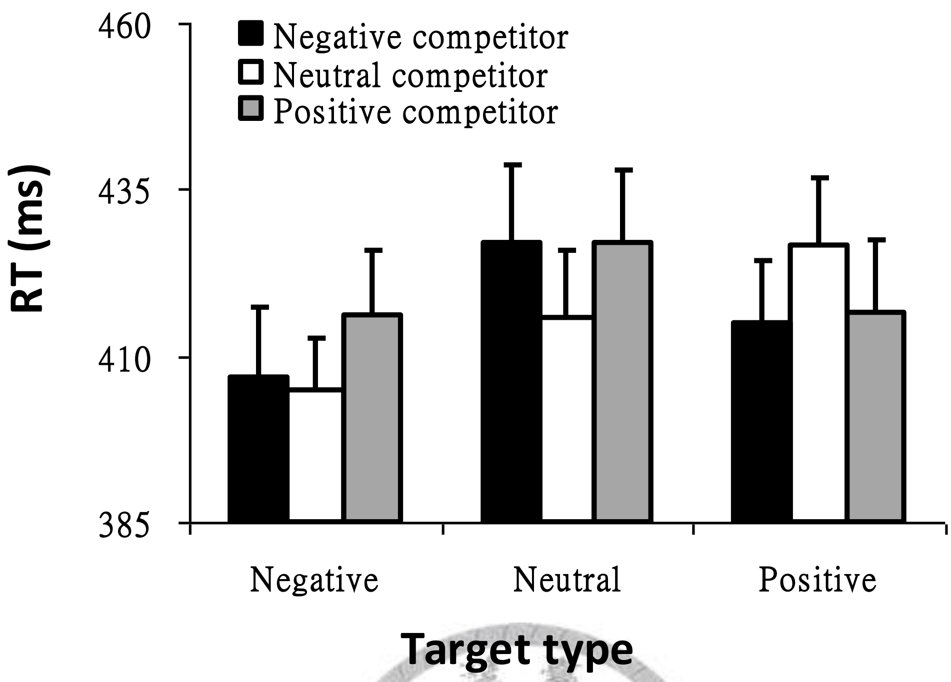


Figure 7. Mean reaction time of probe detection in Experiment 4. Error bars represent one standard error from the mean.

Appendix

(A) The stimuli used in Experiment 1 and 4. The unit of word frequency is times per million words.

	Emotional valence								
	Negative			Neutral			Positive		
	罹患	貪婪	腹痛	瞬間	圍繞	採集	順暢	報酬	務實
	混亂	討厭	弊端	諮詢	察覺	牽涉	親愛	激勵	敏捷
	逃避	絕望	遺棄	模樣	截然	稍後	尊敬	繁華	勤勞
	萎縮	違規	醜聞	歷程	機能	涵蓋	寧靜	禮讓	慈善
	賄選	憂慮	債務	堆積	動搖	搜尋	感恩	甜蜜	楷模
	艱難	虐待	墮落	凝聚	對照	滲透	謹慎	造福	萬歲
	粗糙	病症	廢墟	搭乘	審核	儘速	佳績	鼓舞	歌頌
	消滅	惡夢	癱瘓	運氣	調理	唯獨	推崇	奪魁	寬容
	疲倦	殘疾	說謊	蒸發	輪流	業餘	清新	獎項	憧憬
	瓶頸	徬徨	輿論	緊密	頻率	跨越	細緻	獲勝	信賴
	糊塗	損傷	墓碑	談論	釐清	商量	雄偉	鍛鍊	祝賀
	腫瘤	罰款	窘境	當場	摸索	輕微	寶貴	時髦	恭喜
	後悔	誤會	驅逐	遠處	檢視	廣義	輝煌	悠閒	優越
	腐敗	弱勢	瀕臨	撰寫	脈絡	範疇	穩健	期許	輕盈
	潰瘍	破產	貧窮	根源	連鎖	篩選	逍遙	虔誠	慷慨
	缺陷	殺害	無辜	配置	銜接	縱橫	頂級	純淨	堅毅
Valence		2.58			4.02			5.32	
Arousal		4.49			2.94			4.31	
Frequency		33.0			33.88			32.92	
Stroke Number		13/13			14/13			13/13	

(B)The stimuli used in Experiment 2. The unit of word frequency is times per million words.

Emotional valence					
Negative		Neutral		Positive	
罹患	腹痛	瞬間	採集	順暢	務實
混亂	弊端	諮詢	牽涉	親愛	敏捷
逃避	遺棄	模樣	稍後	尊敬	勤勞
萎縮	醜聞	歷程	涵蓋	寧靜	慈善
賄選	債務	堆積	搜尋	感恩	楷模
艱難	墮落	凝聚	滲透	謹慎	萬歲
粗糙	廢墟	搭乘	儘速	佳績	歌頌
消滅	癱瘓	運氣	唯獨	推崇	寬容
疲倦	說謊	蒸發	業餘	清新	憧憬
瓶頸	輿論	緊密	跨越	細緻	信賴
糊塗	墓碑	談論	商量	雄偉	祝賀
腫瘤	窘境	當場	輕微	寶貴	恭喜
後悔	驅逐	遠處	廣義	輝煌	優越
腐敗	瀕臨	撰寫	範疇	穩健	輕盈
潰瘍	貧窮	根源	篩選	逍遙	慷慨
缺陷	無辜	配置	縱橫	頂級	堅毅
貪婪	恐懼	圍繞	柔軟	報酬	滿意
討厭	生氣	察覺	清晰	激勵	喜悅
絕望	難過	截然	罕見	繁華	開心
違規	憤怒	機能	緩慢	禮讓	愉快
憂慮	無力	動搖	平坦	甜蜜	自在
虐待	恐怖	對照	狹窄	造福	得意
病症	傷心	審核	寬敞	鼓舞	寬心
惡夢	沮喪	調理	職員	奪魁	平靜
殘疾	監獄	輪流	乾脆	獎項	冷靜
徬徨	悲慘	頻率	昂貴	獲勝	歡喜
損傷	罪惡	釐清	讀物	鍛鍊	驚喜
罰款	憂傷	摸索	整齊	時髦	感激
誤會	悲傷	檢視	稀有	悠閒	愉悅

	弱勢	怨恨	脈絡	高大	期許	祥和
	破產	憂鬱	連鎖	典雅	虔誠	歡愉
	殺害	厭惡	銜接	廣闊	純淨	欣喜
Valence	2.50		4.09		5.36	
Arousal	4.53		2.89		4.29	
Frequency	37.66		36.56		40.13	
Stroke Number	13/13		14/13		13/13	

(C) The stimuli used in Experiment 3. The unit of word frequency is times per million words.

	Emotional valence								
	Negative			Neutral			Positive		
	罹患	殘疾	恐懼	瞬間	輪流	柔軟	順暢	獎項	滿意
	混亂	徬徨	生氣	諮詢	頻率	清晰	親愛	獲勝	喜悅
	逃避	損傷	難過	模樣	釐清	罕見	尊敬	鍛鍊	開心
	萎縮	罰款	憤怒	歷程	摸索	緩慢	寧靜	時髦	愉快
	賄選	誤會	無力	堆積	檢視	平坦	感恩	悠閒	自在
	艱難	弱勢	恐怖	凝聚	脈絡	狹窄	謹慎	期許	得意
	粗糙	破產	傷心	搭乘	連鎖	寬敞	佳績	虔誠	寬心
	消滅	殺害	沮喪	運氣	銜接	職員	推崇	純淨	平靜
	疲倦	腹痛	監獄	蒸發	採集	乾脆	清新	務實	冷靜
	瓶頸	弊端	悲慘	緊密	牽涉	昂貴	細緻	敏捷	歡喜
	糊塗	遺棄	罪惡	談論	稍後	讀物	雄偉	勤勞	驚喜
	腫瘤	醜聞	憂傷	當場	涵蓋	整齊	寶貴	慈善	感激
	後悔	債務	悲傷	遠處	搜尋	稀有	輝煌	楷模	愉悅
	腐敗	墮落	怨恨	撰寫	滲透	高大	穩健	萬歲	祥和
	潰瘍	廢墟	憂鬱	根源	儘速	典雅	逍遙	歌頌	歡愉
	缺陷	癱瘓	厭惡	配置	唯獨	廣闊	頂級	寬容	欣喜
	貪婪	說謊	厭煩	圍繞	業餘	堅固	報酬	憧憬	欣慰
	討厭	輿論	無助	察覺	跨越	修築	激勵	信賴	自豪
	絕望	墓碑	悲痛	截然	商量	崎嶇	繁華	祝賀	快活
	違規	窘境	痛恨	機能	輕微	豐盛	禮讓	恭喜	欣然
	憂慮	驅逐	懊惱	動搖	廣義	交錯	甜蜜	優越	愜意
	虐待	瀕臨	憤慨	對照	範疇	潮濕	造福	輕盈	開朗
	病症	貧窮	無望	審核	篩選	堅硬	鼓舞	慷慨	快意
	惡夢	無辜	妒忌	調理	縱橫	壯麗	奪魁	堅毅	狂喜
Valence	2.50			4.11			5.34		
Arousal	4.49			2.85			4.28		
Frequency	35.11			35.00			36.97		
Stroke Number	13/13			12/13			13/13		