Bilingualism: Language and Cognition

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Research Article

Cite this article: Ye, X., & Zhao, C. (2024). Cross-language semantic-affective interaction – with evidence from Chinese EFL learners. *Bilingualism: Language and Cognition*, **27**, 810–820. https://doi.org/10.1017/S1366728923000895

Received: 20 October 2022
Revised: 17 November 2023
Accepted: 20 November 2023
First published online: 10 January 2024

Keywords:
semantic priming; affective priming; cross-language emotion word representation; bilingual mental lexicon

Corresponding author:
Cuilian Zhao
Email: clzhao@sisu.edu.cn

Cross-language semantic-affective interaction – with evidence from Chinese EFL[1] learners

Xuanchen Ye[1] and Cuilian Zhao[2]

[1]School of Foreign Languages, Central China Normal University, Wuhan, China and [2]Center for Linguistics, Literary & Cultural Studies/Dictionary Research Center, Sichuan International Studies University, Chongqing, China

Abstract

Semantic and affective priming have long been treated separately in psycholinguistic studies. Recently, however, the question of whether and how these two primings interact has become controversial, especially in cross-language contexts where such discussions are rare. In the present study, four mixed-design experiments were conducted with Chinese EFL learners to investigate cross-language semantic-affective interactions: 3 (prime valence: negative, positive, neutral) × 2 (semantic relatedness: related, unrelated). Results show that semantic priming effects occurred in the L1→L1 and L1→L2 conditions, whereas affective priming effects were observed in the L2→L2 condition. In the L2→L1 priming condition, only emotion primes induced cross-language priming. These results suggest that semantic and emotional accesses are activated automatically and separately, but can facilitate cross-language word processing mutually. The results support the hierarchical representation of semantic features of emotion words from L1 to L2 in the unbalanced bilingual mental lexicon, while affective attributes are spread across a distributed network.

Semantic-affective interaction

The interaction between semantic and affective priming has been debated in psycholinguistics for over a decade (Hu & Liu, 2019; Jiang et al., 2012; Storbeck & Clore, 2008). Traditionally, priming effects have been associated with semantic priming, where response times are faster when targets (e.g., *dog*) follow semantically related word primes (e.g., *cat*) than unrelated primes (e.g., *table*) (Altarriba, 1992; Neely, 1991). Semantic priming operates on the basis of shared semantic features, independent of emotional attributes.

Fazio et al. (1986) were the first to observe that a faster response can occur when the prime and target have the same emotional valence (positive or negative), even in the absence of semantic relatedness. This finding introduced the concept of affective priming.

Research generally supports the notion that semantic and emotional access operate independently and exhibit unique characteristics. For instance, Blair et al. (2006) found that individuals with psychopathy showed lower levels of affective priming than a control group, while both groups showed similar levels of semantic priming. Studies employing Event-Related Potential (ERP) and functional Magnetic Resonance Imaging (fMRI) have identified distinct neural regions associated with semantic and affective priming, supporting their separate processing (Eder et al., 2012; Liu et al., 2010).

Regarding the causal relationship between semantic and affective meaning, hypotheses propose either semantic priming or affective response priming as the cause of affective priming (Eder et al., 2012; Hu & Liu, 2019). Proponents of semantic priming dominance argue that the spreading activation in a semantic network or a distributed memory system leads to affective priming (Fazio, 2001; Spruyt et al., 2007). In contrast, proponents of affective response priming believe that the automatic activation of affective attributes themselves underlies affective priming (Houwer et al., 2002; Klinger et al., 2000).

Studies have demonstrated subliminal affective priming, suggesting that emotional processing may occur prior to semantic processing (Fazio, 2001; Houwer et al., 2002; S. S. Li & Li, 2007; Liao & Tao, 2004). This perspective is referred to as the 'affective primacy hypothesis', which posits that emotional information is retrieved at the initial stage of word processing (Klauer & Musch, 2003; Zajonc, 2000). However, opposing views, such as the 'cognitive primacy hypothesis', suggest that semantic processing precedes and is essential for affective processing (Lazarus & Folkman, 1984; Storbeck & Robinson, 2006). For example, Nummenmaa et al. (2010) found faster semantic categorization responses than affective categorization in their experiments, suggesting a cognitive precedence.

This article has earned badges for transparent research practices: Open Data and Open Materials. For details see the Data Availability Statement.

Furthermore, some studies argue that both semantic processing and affective processing constitute affective priming effects, as in Eder et al. (2012). However, the research suggested that semantic and affective variables should be manipulated independently in future studies.

Notably, the 'cognitive primacy hypothesis' often depicts affective priming as subordinate to, and much weaker than, semantic priming (Hu & Liu, 2019; Nummenmaa et al., 2010). Storbeck and Robinson (2004) found that affective priming was relatively weak and only occurred when the research stimuli belonged to the same semantic category. In contrast, semantic priming occurred despite variations in task type, stimuli, and stimulus-onset asynchrony (SOA). However, in a replication experiment, Storbeck and Clore (2008) obtained contrary results, showing that only affective priming was observed in the evaluation task. The strength of affective and semantic priming effects is strongly dependent on task type.

In summary, researchers acknowledge the distinctiveness of affective and semantic priming, but there is a lack of consensus as to which takes precedence or is more robust. Furthermore, discussions have primarily focused on monolingual contexts, with limited exploration of cross-language semantic-affective interactions (Cao & Wang, 2018; Jiang et al., 2012; Sianipar et al., 2015).

Cross-language lexical representation

Various models have been proposed in bilingual studies to unravel the complexities involved in cross-language lexical processing. Among these models, the Revised Hierarchical Model (RHM) provides insights into the dynamic development of the cognitive system concerning L2[2] acquisition (Kroll & Sholl, 1992; Kroll & Stewart, 1994). The RHM delineates critical components, including the lexical and conceptual levels in both languages, the connections between them, and the varying strengths of these connections, represented by solid and dotted lines (see Figure 1). It posits that forward translation (from L1 to L2) can be slower than backward translation (from L2 to L1), primarily due to the greater challenge of mapping L1 words to their L2 equivalents (indicated by the dotted line) compared to the reverse process (indicated by the solid line).

Numerous studies have supported the principles of the RHM, consolidating its status as one of the most widely accepted models of bilingual memory representation (Heredia & Altarriba, 2014). Nevertheless, the RHM exhibits conspicuous limitations when it comes to explaining affective-semantic interactions. It was originally conceived to address translation asymmetries observed in bilingual individuals. In terms of semantic priming effects, stronger priming is typically observed from L1 to L2 than from L2 to L1, contrary to translation asymmetries. Furthermore, the RHM primarily emphasizes conceptual links between L1 and L2 words. However, associations between words in different languages at the affective level do not follow a linear pattern, as is the case for semantic associations. Several studies on affective priming have reported emotion effects of equal or even greater intensity in L2 than in L1 (Ayçiçeği & Harris, 2004; El-Dakhs & Altarriba, 2018; Ferré et al., 2010; Ponari et al., 2015). Consequently, the RHM proves inadequate for interpreting priming effects associated with affective influences.

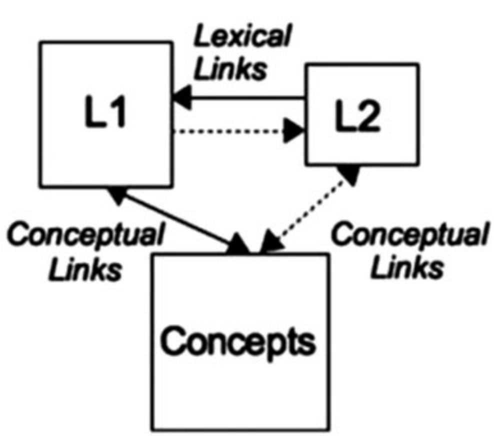

Figure 1. Revised Hierarchical Model (Adapted from Kroll and Stewart, 1994)

Another prominent model of bilingual memory representation is the Distributed Feature Model (DFM). The DFM effectively explains the differences in processing effects across different word types. In particular, concrete words tend to be translated more rapidly than abstract words. According to Paivio (1986), concrete translation pairs exhibit a higher degree of semantic similarity than abstract pairs, with the former sharing more conceptual nodes in the DFM. Similarly, Li (2018) reported that, among the three word categories (nouns, verbs, and adjectives), nouns elicited stronger semantic priming effects than verbs, which, in turn, elicited stronger effects than adjectives. These findings support the notion of a descending order of concreteness among these categories.

The DFM, with its concreteness effect phenomenon, underscores that concrete words are generally easier to encode, store, retrieve, and translate than abstract words (Altarriba, 2014). However, our particular interest lies in the application of the DFM to emotion words, or more specifically, the emotion effect. Intriguingly, emotion words, despite receiving low concreteness ratings (Altarriba et al., 1999), consistently exhibit processing advantages over neutral words, including faster translation between languages. This observation raises questions about whether the representation of emotion words in L1 and L2 is consistent with the DFM. Furthermore, emotion words have been shown to induce backward priming effects (from L2 to L1) or to evoke emotions with similar intensity in L2 as in L1 among unbalanced bilinguals and late L2 learners (Ayçiçeği & Harris, 2004; El-Dakhs & Altarriba, 2018; Ferré et al., 2010; Ponari et al., 2015). These findings challenge the predictions of current models.

In summary, although the RHM and the DFM are prominent theoretical models of bilingual memory representation, they do not fully account for the unique characteristics of emotion word representation. The RHM fails to differentiate between word types, while the DFM, although providing a more comprehensive perspective than the RHM, falls short in capturing the nuanced features associated with emotion words. Both models primarily focus on the extent of semantic activation and overlap between words in different languages. However, the processing of emotion words is complex due to the intricate interplay between semantic effects and affective influences. As Pavlenko (2005) points out, emotion words necessitate the separation of conceptual and semantic representations.

Models of emotion word processing, such as the Spreading Activation Model (SAM, Fazio et al., 1986), primarily explore the psychological mechanisms underpinning the affective aspects of words within a monolingual mental lexicon. However, none of these models has effectively incorporated the complex interaction between semantic effects and affective influences in cross-language emotion word representation.

In conclusion, existing theoretical models do not comprehensively address the issue of cross-language emotion word representation. The interplay between semantic and emotional access in mixed-language contexts challenges the predictability of effects produced by emotion primes, thus complicating the applicability of these models. Therefore, it is imperative to distinguish the emotion category within the bilingual mental lexicon and to investigate its distinctive patterns in cross-language processing.

Cross-language emotion word processing

Research on emotion processing in bilinguals has yielded a complex and multifaceted picture. Bilinguals often show a preference for using their second language (L2) when discussing sensitive or anxiety-provoking topics, as observed in classic studies such as Bond and Lai's (1986), where Chinese undergraduates gave more elaborate responses in L2 to embarrassing questions. Dewaele's (2004) investigation into emotional responses to swear and taboo words among bilinguals showed that such words elicited stronger emotions in the native language (L1), which gradually decreased in later-acquired languages. Similar trends were found for the phrase "I love you" among adult multilinguals. Eilola and Havelka (2011) and Caldwell-Harris et al. (2011) studied skin conductance responses (SCRs) in different linguistic contexts. They found higher SCRs for negative/taboo words in L1 than in L2. These findings are consistent with the Foreign Language Effect, which suggests that words in a less familiar language (e.g., L2) tend to carry less emotional weight (Altarriba, 2014; Rosselli et al., 2017).

However, the existing literature is not entirely consistent. Some studies, such as Anooshian and Hertel (1994), found higher recall rates for emotion words than neutral words exclusively in the native language, suggesting an L1 advantage in memory tasks. Conversely, Ayçiçeği and Harris (2004) reported a stronger emotion-memory effect for negative words in the L2. They argued that L2 words retain rich emotional associations for bilinguals.

The variability in research findings can be attributed to numerous factors, as highlighted by Rosselli et al. (2017). These factors include the age of language acquisition, the frequency of language use, the context in which each language was acquired, experimental task types, language proficiency, language dominance, the linguistic distance between languages, differences in orthographic systems, bilingual processing strategies, and the nature of emotional stimuli. Investigating the differences in emotional processing between L1 and L2 is a challenging task that requires careful consideration and control of these variables.

The present study

This study delves into the intriguing domain of semantic-affective priming effects, particularly in cross-language conditions. The aim is to determine if and how changes in semantic-affective interaction occur when switching languages. Two specific research questions will be addressed:

(1) Do semantic effects and affective influences manifest themselves in single language priming (L1→L1 & L2→L2)? If so, how do they function? In particular, do they function in parallel or interactively?

(2) Do semantic effects and affective influences persist in cross-language priming (L1→L2 & L2→L1)? If so, how do they function? In particular, do they function in parallel or interactively?

Based on the insights gained from these questions, we delve deeper into the representation of emotion words in cross-language scenarios. We seek to answer pressing questions such as whether Chinese EFL learners maintain shared or separate storage for the conceptual representation of emotion words in their bilingual mental lexicon. We also investigate whether emotion words in the bilingual mental lexicon are organized hierarchically or exhibit distributed features. Furthermore, we aim to identify additional characteristics related to the cross-language representation of emotion words.

Four experiments were designed to investigate the interaction between semantic and affective priming. Each experiment employed a Lexical Decision Task (LDT) paradigm with a 3 (prime valence: positive, negative, neutral) × 2 (semantic relatedness: related, unrelated) mixed design. The LDT was chosen due to its proven effectiveness in eliciting both semantic and affective priming effects (Eder et al., 2012; Hu & Liu, 2019; Sianipar et al., 2015). For example, Storbeck and Robinson (2004) observed the semantic priming effect using the LDT, and Storbeck and Clore (2008) extended this to include both semantic and affective priming. It is noteworthy that both studies were conducted in English (L1 for the participants).

In the present study, the first experiment used Chinese primes and targets (L1 for the participants), while the second experiment used only English materials (L2 for the participants). In contrast, Experiment III involved priming from L1 primes to L2 targets, and Experiment IV examined the reverse, from L2 primes to L1 targets, with the explicit aim of investigating cross-language priming effects.

Materials

The research materials for the study were carefully selected using a combination of corpus-based research and subjective peer review. The first experiment used only Chinese real-word and pseudoword pairs, while the second used English word pairs. The third and fourth experiments adopted Chinese–English and English–Chinese prime-target word pairs respectively. Each experiment included a total of 42 formal word pairs and 42 pseudoword pairs (see Appendix 5).

The initial selection included 224 Chinese words sourced from the Chinese Affective Words System (CAWS, Wang et al., 2008). Semantically related words for these Chinese words were further identified using Chinese Synonyms for Natural Language Processing and Understanding (Wang & Xi, 2017), resulting in a preliminary selection of 163 semantically related word pairs and 163 unrelated word pairs.

Subjective ratings were crucial in refining our selection. We recruited 268 undergraduate participants from three universities across China, randomly divided into three groups. They were tasked with rating the relatedness of Chinese word pairs (Appendix 2), the valence of Chinese words (Appendix 3), and the familiarity of English words (Appendix 4) using 5-point or 9-point Likert scales. The first group of raters also provided English equivalents for semantically related Chinese word pairs (Appendix 1). From these ratings, 150 English words were selected by filtering out those with valence values above the specified thresholds using Affective Norms for English Words (ANEW: Bradley & Lang, 1999). The third group of raters further contributed to the final selection of English word materials. Any English words that did not meet the requirements resulted in the corresponding Chinese counterparts being discarded.

Statistical analyses were conducted to ensure that the selected word pairs were well-matched. Significant differences were found in valence degrees between positive, negative, and neutral primes in both Chinese and English (all $ps < .001$), as well as between related and unrelated pairs (all $ps < .001$). However, no significant differences were observed in familiarity, log frequency, or number of strokes for Chinese words (all $ps > .05$), and in familiarity, log frequency, number of syllables, or word length for English words (all $ps > .1$). This rigorous matching process allowed us to categorize Chinese–English word pairs into six distinct categories based on their emotional valence and semantic relatedness.

In addition to the formal word pairs, the present study included 84 filler items, consisting of 42 English and 42 Chinese pseudowords. The English pseudowords were generated using Wuggy, a multilingual pseudoword generator (Keuleers & Brysbaert, 2010). These pseudowords were both orthographically and phonologically legal English nonwords, e.g., *bunefit*, *hespital*, and were matched for the number of syllables (all $ps > .1$) and word length (all $ps > .1$). Chinese nonwords were created by our team according to orthographic and phonological standards, resulting in two-character pseudowords such as 田答 and 行季. They were also matched for the number of strokes (all $ps > .1$).

Participants

A total of 438 Chinese EFL learners participated in the research. Among them, 268 participated in the subjective evaluations of the research material selection. In addition, 40 individuals (20 males, 20 females) participated in Experiment I, another 40 (20 males, 20 females) participated in Experiment II, while 45 (23 males, 22 females) and 45 (22 males, 23 females) participated in Experiments III and IV, respectively.

All participants in the formal experiments were undergraduate non-English majors from a top university in southwest China, aged between 18 and 22. The age distribution for each experiment was as follows: Experiment I: $M = 19.56$ years, $SD = 1.14$; Experiment II: $M = 20.46$ years, $SD = .94$; Experiment III: $M = 20.51$ years, $SD = 1.10$; Experiment IV: $M = 20.13$ years, $SD = 1.08$. They acquired their English skills primarily through formal instruction at school and had passed the College English Test Band 4 (CET-4) at the time of the experiment, although they had not yet taken the College English Test Band 6 (CET-6). All participants were right-handed, had no history of mental illness, and had normal or corrected-to-normal vision, which ensured that they could effectively engage with the word stimuli on the computer. Their voluntary participation was motivated by the opportunity to earn additional course credits.

To ensure the credibility of the selected materials, an independent-sample t-test was used to carefully match the backgrounds of the subjective raters and formal experiment participants. The test results showed that the two groups were not significantly different in terms of average age, years of formal education, years of English language acquisition, and mean CET-4 scores (all $ps > 0.1$). In addition, participants in all four experiments were strictly matched for average age, years of formal education, years of English language acquisition, and mean CET-4 scores (all $ps > 0.1$). Consequently, all participants can be considered homogeneous peers with comparable educational backgrounds and language proficiency levels.

Experiment I: L1 (Chinese)

Design

This experiment was designed to examine whether L1 emotion words exerted a priming effect on semantically related or unrelated L1 target words. It was designed and launched using E-prime version 3.0 on laptops. All participants were tested individually in a quiet laboratory. Instructions in Chinese were displayed on the computer screen and were verbally reinforced by the experimenter, who remained in the room during the experiment and provided guidance to ensure that participants maintained a fixed head position, focused on the fixation point, and maintained a consistent distance from the computer screen, etc.

The whole procedure consisted of two phases, with the formal phase containing 72 trials representing 12 repetitions of 6 conditions. In the training phase, participants completed 12 trials with stimuli that were not present in the formal phase, allowing them to familiarize themselves with the procedure. Participants' accuracy rates and reaction times (RTs) were recorded for analysis. Access to the formal phase was granted upon full comprehension of the task.

On each trial, a fixation cross ("+") appeared for 300 ms to center participants' attention. Subsequently, a Chinese prime was displayed for 350 ms, followed by a 150 ms blank screen interval. A Chinese target word then appeared at the same location and remained until the participant responded or up to a maximum of 1000 ms. The SOA was fixed at 500 ms. An inter-trial interval of 1000 ms separated each trial (see Figure 2). Participants were instructed to perform an LDT by pressing "1" for a word or "9" for a nonword.

Results

Mean RTs and accuracy rates were calculated for each participant in each condition. Accuracy rates below 70% were trimmed from the remaining data[3]. RTs were trimmed by removing responses that were more than 3.0 standard deviations from the overall mean. Thirty-six participants' data were retained for further analysis (see Table 1).

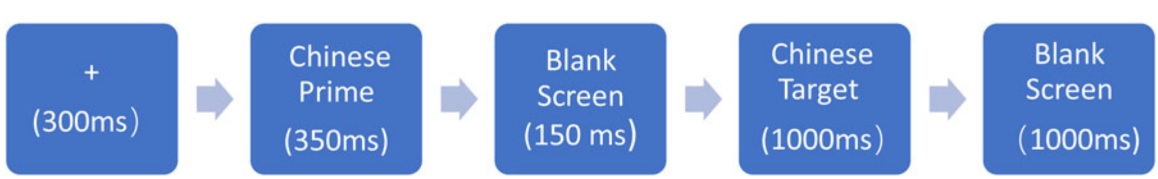

Figure 2. Single Trial Demonstration for Experiment I

https://doi.org/10.1017/S1366728923000895 Published online by Cambridge University Press

Table 1. *Mean RTs (in ms) and Accuracy Rates (in brackets) in Experiment I*

	Valence		
Semantic Relatedness	Positive	Negative	Neutral
Related	588.82 (.88)	578.81(.83)	593.30(.84)
Unrelated	604.23(.84)	624.08(.81)	607.38(.87)

Two-factor repeated-measure ANOVAs were conducted to analyze accuracy rates. The results indicated a marginally significant interaction between the valence of prime stimuli and prime-target relatedness (F (2,34) = 2.993, p = .064, η^2 = .150). No significant main effect was observed for valence (F (2,34) = 2.260, p = .120) or relatedness (F (1,35) = .016, p = .899).

Results from repeated-measure ANOVAs on RTs revealed a significant main effect for relatedness (F (1,35) = 14.848, p < .001, η^2 = .298), with RTs for related conditions being significantly faster than unrelated ones. No significant main effect was found for valence (F (2,34) = .224, p = .800), and no significant 3 (valence) × 2 (relatedness) interaction was detected (F (2,34) = 2.003, p = .150).

Discussion

The analysis of accuracy rates revealed no significant differences between the different conditions in Experiment I. However, semantic priming effects were evident in the RTs, with related conditions showing significantly faster responses than unrelated pairs. Surprisingly, despite the use of emotion primes, no affective priming effect was observed.

Several studies using L1 (Chinese) materials and Chinese participants have reported significant affective priming effects. For example, Chen and Li (2016) found these effects using valence evaluation tasks with both English and Chinese materials. Ye and Zhao (2022) detected priming effects on emotion-laden words in Chinese using the Affect Misattribution Paradigm.

In contrast, Experiment I primarily observed a semantic priming effect and did not detect any affective priming effect. Hu and Liu (2019) also used LDTs and recorded the absence of an affective priming effect when semantic associative strength was low. However, the semantic priming effect persisted even when affective congruence was not maintained. Accordingly, they argued that semantic processing is more obligatory than affective processing.

Two possible explanations may account for the results of Experiment I. First, semantic features may dominate over affective valence processing because the former can occur without triggering the latter, which appears to be more conditional. Second, semantic word representation may overshadow affective representation in LDTs performed in the L1. Ihmels et al. (2016) observed an affective priming effect in unrelated rather than related trials, which they attributed to a floor effect in which the associative context accelerated the overall response times for related pairs, making them too fast for the affective priming to manifest. Previous studies have shown that LDTs often produce more robust semantic priming effects than affective priming effects (Eder et al., 2012; Houwer et al., 2002; Klinger et al., 2000; Storbeck & Clore, 2008; Storbeck & Robinson, 2004). Therefore, it is plausible that the extensive semantic association network of L1 words could distract participants' attention from affective influences.

Experiment II: L2 (English)

Design

Experiment II replicated the procedure of Experiment I with one key difference – the materials were replaced by English words. A single trial demonstration is shown in Figure 3.

Results

Mean RTs and accuracy rates were computed and calculated for each participant in the same manner as in Experiment I. Data from 35 participants were retained for further analysis (see Table 2).

Two-factor repeated-measure ANOVAs were conducted to analyze accuracy rates. The results revealed a significant main effect for valence (F (2, 33) = 4.509, p = .019, η^2 = .215). Although no significant main effect was found for relatedness (F (1, 34) = .260, p = .613), the interaction between valence and relatedness was significant (F (2, 33) = 18.655, p < .001, η^2 = .531).

Results from repeated-measure ANOVAs on RTs revealed a significant main effect for valence (F (2, 33) = 5.584, p = .012, η^2 = .370). Specifically, RTs for emotion primes were significantly shorter than for neutral primes. No significant main effect was found for relatedness (F (1,34) = .448, p = .511), nor was there any significant 3 (valence) × 2 (relatedness) interaction (F (2,33) = 1.070, p = .363).

Discussion

The results of Experiment II revealed a distinct affective priming effect, characterized by faster RTs for emotion primes compared to neutral words. In addition, the positive-related group exhibited significantly higher accuracy rates than the other groups.

Previous studies have shown that varying task types yield different priming effects, while the present study found that language differences also influence the type of priming effects observed. Both Experiments I and II used LDTs, but only L1 priming induced a semantic priming effect. This suggests that semantic access may be more stable in L1 than in L2, a phenomenon that is consistent with previous studies that have primarily used performance tasks in L1.

Furthermore, although no semantic priming was observed in the L2 LDTs, an affective priming effect was induced, contradicting the first possibility suggested in the discussions of Experiment I.

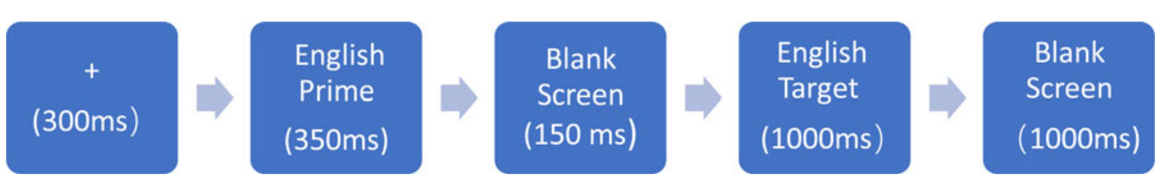

Figure 3. Single Trial Demonstration for Experiment II

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Table 2. *Mean RTs (in ms) and Accuracy Rates (in brackets) in Experiment II*

	Valence		
Semantic Relatedness	Positive	Negative	Neutral
Related	572.26(.84)	575.48(.71)	610.91(.74)
Unrelated	573.19(.71)	580.44(.76)	594.25(.80)

Table 3. *Mean RTs (in ms) and Accuracy Rates (in Brackets) in Experiment III*

	Valence		
Semantic Relatedness	Positive	Negative	Neutral
Related	573.83(.86)	538.80(.85)	608.31(.84)
Unrelated	644.22(.82)	679.08(.82)	610.38(.88)

Two further important suggestions were made. First, the results of the study support the 'affective primacy hypothesis', suggesting that the emotional attributes of L2 words can be activated and spread without semantic facilitation. Second, semantic access can be hierarchically represented from L1 to L2, whereas emotional access connects distributed nodes in a shared network in both languages. Interestingly, participants recognized semantically related words faster in their native language than in a foreign language. The evidence suggests that the semantic associations with shared concepts are more robust in L1 than in L2, suggesting an asymmetric representation of semantic access in the bilingual mental lexicon. Conversely, emotional access is characterized by a distributed representation, as evidenced by the presence of affective priming effects when switching to a foreign language.

Experiment III: L1 (Chinese)→L2 (English)

Design

Experiment III replicated the procedures of the previous experiments, except for the materials. In this experiment, all primes were Chinese words, and all targets were English. A single trial demonstration is shown in Figure 4.

Results

Mean RTs and accuracy rates were computed and calculated for each participant, following the same methodology as in the previous experiments. Data from 36 participants were retained for further analysis (see Table 3).

Two-factor repeated-measure ANOVAs were conducted to analyze accuracy rates. The results revealed a significant interaction between the valence of the prime stimuli and the prime-target relatedness ($F\ (2,34) = 9.892$, $p < .01$, $\eta^2 = .368$). No statistically significant main effects were found in any of the analyses.

Results from repeated-measure ANOVAs on RTs revealed a significant main effect for relatedness ($F\ (1,35) = 120.285$, $p < .001$, $\eta^2 = .775$). Specifically, RTs for related conditions were shorter than those for unrelated conditions. No significant main effect was found for valence ($F\ (2,34) = .001$, $p = .999$), but the 3 (valence) × 2 (relatedness) interaction was significant ($F\ (2,34) = 37.277$, $p < .001$, $\eta^2 = .687$). In related conditions, RTs were faster for negative than for positive word pairs ($p = .042$), and faster for positive than for neutral word pairs ($p = .037$). When the prime and the target were unrelated, RTs were faster for neutral than for positive word pairs ($p = .031$), and faster for positive than for negative word pairs ($p = .004$).

Discussion

The results of Experiment III showed a significant main effect for relatedness and an interaction between valence and relatedness, indicating the presence of a dual-route cross-language priming effect. First, the semantic priming effect occurred for both emotion and neutral primes, suggesting a shared memory for bilingual concepts regardless of word valence. It allows L1 primes to directly access semantic features, which are then activated and spread to related nodes in the shared storage, accelerating responses to L2 targets.

In addition, RTs for emotion primes paired with related targets were significantly faster than for incongruent pairs. Among emotion words, responses to negative words were faster than positive words when related, but slower when unrelated. In summary, an affective facilitation effect accompanied the semantic effect in cross-language priming. Such processing advantage was more pronounced for negative words than for positive words.

In general, the priming effects found in Experiment III demonstrated the interaction of semantic and affective properties. Both are likely to have been extracted at a very early stage of word processing, which is in line with several available monolingual word studies, mostly in L1, suggesting the occurrence of valence during a primary visual analysis or an early perceptual stage (Scott et al., 2009; Skrandies, 1998). Furthermore, such valence activation extends during L1 to L2 word processing, thus activating the affective representation of L2 words to facilitate or inhibit target processing, as found by Sianipar et al. (2015). The results also provide evidence that the semantic and affective features are extracted separately and yet processed interactively.

Experiment IV: L2→L1

Design

Experiment IV replicated the procedures of the previous experiments, except for the materials. In this experiment, all primes were English words, and all targets were Chinese words. A single trial demonstration is illustrated in Figure 5.

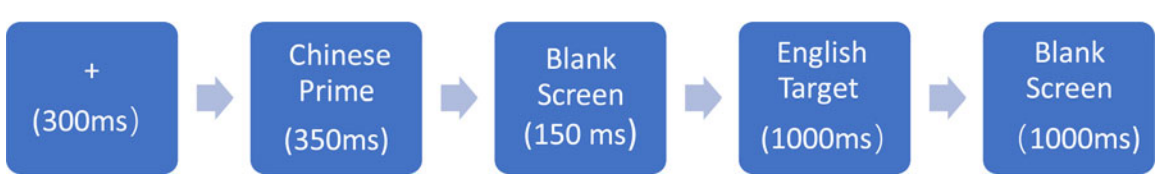

Figure 4. Single Trial Demonstration for Experiment III

https://doi.org/10.1017/S1366728923000895 Published online by Cambridge University Press

Figure 5. Single Trial Demonstration for Experiment IV

Results

Mean RTs and accuracy rates were computed and calculated for each participant, using the same methodology as in the previous experiments. Data from 35 participants were retained for further analysis (see Table 4).

Two-factor repeated-measure ANOVAs were conducted to analyze accuracy rates. The results revealed a significant main effect for valence (F (2,33) = 4.531, p = .018, η^2 = .215), indicating that accuracy rates were significantly higher for the positive and neutral groups than for the negative groups. While no significant main effect for semantic relatedness was found (F (1,34) = 2.806, p = .103), the interaction between valence and relatedness was pronounced (F (2,33) = 19.555, p < .001, η^2 = .542).

Results from repeated-measure ANOVAs on RTs revealed a significant main effect for relatedness (F (1,34) = 48.263, p < .001, η^2 = .587), with RTs for related conditions being significantly shorter than those for unrelated conditions. No significant main effect was found for valence (F (2,33) = .104, p = .902), but the 3 (valence) × 2 (relatedness) interaction was significant (F (2,33) = 31.395, p < .001, η^2 = .655). In related conditions, RTs were significantly faster for positive than for negative word pairs (p = .001), and significantly faster for negative than for neutral word pairs (p = .005). When the prime and the target were unrelated, RTs were significantly faster for neutral than for negative word pairs (p = .002), and significantly faster for negative than for positive word pairs (p < .001). In semantically related conditions, RTs were significantly faster in both positive (p < .001) and negative (p = .002) groups than in unrelated conditions, whereas the reverse was true in neutral conditions (p = .001).

Discussion

The results of Experiment IV showed that participants responded faster to related targets than to unrelated targets when the primes were emotion words rather than neutral words. This suggests that the cross-language semantic priming effects in Experiment IV occurred predominantly in the emotion word conditions. Such findings suggest that L2 emotion words may have direct access to shared conceptual storage, whereas neutral words in the L2 lexicon access the conceptual storage through mediation by L1 conceptual representations, leading to longer RTs.

In summary, emotional access in the cross-language context may operate both interactively with and separately from semantic access, consistent with the results of Experiment I. This simultaneous processing of emotional and semantic access suggests that the extraction of affective properties begins no later than that of semantic properties.

Table 4. *Mean RTs (in ms) and Accuracy Rates (in Brackets) in Experiment IV*

	Valence		
Semantic Relatedness	Positive	Negative	Neutral
Related	515.43(.91)	550.88(.80)	580.72(.83)
Unrelated	617.99(.83)	583.16(.86)	548.38(.91)

Difference tests on Experiments III and IV

To evaluate cross-language priming effects in different directions, we compared the results of Experiments III (Chinese to English) and IV (English to Chinese). The experiments investigated how the direction of priming (from L1 to L2 and vice versa) and the valence of the primes (positive, negative, neutral) influenced the size of the priming effects. To compare Experiments III and IV, the size of priming effects was calculated by subtracting related RTs from unrelated RTs. These values were then analyzed using a 3 (prime valence: positive/negative/neutral) × 2 (priming direction: L1 to L2/L2 to L1) two-factor mixed ANOVA (see Table 5).

The ANOVAs revealed significant main effects for both valence (F (2,68) = 40.894, p < .001, η^2 = .372) and priming direction (F (1,69) = 20.297, p < .001, η^2 = .227). Notably, the magnitude of the effect was significantly larger for emotion primes than for neutral primes. Besides, the effect magnitude of Experiment III (Chinese to English) was significantly larger than that of Experiment IV (English to Chinese).

In addition, a significant interaction between prime valence and priming direction was found (F (2,68) = 14.630, p < .001, η^2 = .175). In Experiment III, the effect magnitude of negative primes was significantly larger than that of positive primes (p = .001), which was larger than that of neutral primes (p < .001). In Experiment IV, the effect magnitude of positive primes was significantly larger than that of negative primes (p < .001), which was larger than that of neutral primes (p < .001).

These results indicate that cross-language priming effects were significant for all types of primes in Experiment III (from L1 to L2), regardless of valence. However, in Experiment IV (from L2 to L1), only emotion words, as opposed to neutral words, elicited priming effects.

The observed asymmetric magnitudes of priming effects between Experiments III and IV suggest a hierarchical representation of semantic access between L1 and L2, consistent with the findings of Experiments I and II. While L1 priming facilitated the semantic processing of L2 words, the reverse direction, from L2 to L1, revealed that affective attributes in L2 priming served as facilitative factors in the processing of L1 words.

Table 5. *Mean Difference on Size of Priming Effects (in ms) and Standard Deviations (M ± SD) between Experiments III and IV*

	Positive	Negative	Neutral
L1 to L2	70.40 ± 99.85	140.29 ± 75.71	2.07 ± 73.17
L2 to L1	102.56 ± 62.50	32.28 ± 55.94	-32.34 ± 51.78

Furthermore, the larger magnitude of the effects induced by emotion primes than by neutral primes suggests that emotion words may access conceptual storage before neutral words. Although semantic access appeared to be hierarchical in the association of L1 and L2 lexicons, emotion words were able to elicit cross-language priming effects in both directions, suggesting that affective attributions are stored, activated, and processed in a distributed manner.

General discussion

The results of this series of experiments provide insights into the complex interplay between semantic and affective priming in a bilingual context and shed light on the dual-access nature of cross-language priming. The results revealed a fascinating pattern: priming within the L1 (Chinese) produced primarily a semantic priming effect, whereas priming within the L2 (English) induced primarily an affective priming effect. However, the dynamics shifted when cross-language priming was examined: L1→L2 priming led to both semantic and affective priming, whereas L2→L1 priming showed cross-language effects primarily for emotion words, where semantic and affective priming interacted and influenced each other.

Several noteworthy findings can be generalized from the analysis of the results.

First, semantic and affective priming can occur independently, challenging the widely held 'cognitive primacy hypothesis', which posits that semantic processing is a prerequisite for affective processing. The findings challenge the hypothesized causal relationship between semantic and affective priming and the notion of a rigid sequential order. Furthermore, the results indicate that neither semantic priming nor affective priming is consistently stronger or more stable than the other, suggesting that the relative strength of these priming effects may depend on the direction of priming in cross-language conditions.

Moreover, the present study is consistent with previous research in suggesting that the processing of emotion words differs between the native language (L1) and the second language (L2). In particular, we observed no affective priming effect when the LDT was performed in participants' dominant language (Chinese), whereas such an effect was detected in a similar task carried out in their second language (English). According to Ayçiçeği and Harris (2004), the "unexpectedness and novelty" of the L2 (English) items may facilitate deeper processing than otherwise. In other words, L2 words, including emotion words, may be perceived as more novel or amusing than L1 words. However, our study suggests that novelty alone does not account for the L2 processing advantage observed for emotion words; the effect appears to be exclusive to emotion words and not a general feature of L2 processing. Consequently, it seems that emotion words somehow enhance the "unexpectedness and novelty" of L2, amplifying the contrast between emotion and neutral words in L2 compared to L1. This finding is further supported by Basnight-Brown (2009), who found that emotion words are processed more rapidly in L2 than in L1.

In particular, our findings resonate with the well-documented Foreign Language Effect, which typically refers to a sense of detachment in the perception of L2 words. The effect involves a direct comparison between L2 emotion words and their L1 counterparts, suggesting that L2 emotion words generally convey less emotional weight than their L1 counterparts. However, this study introduces a fresh perspective by comparing the contrast between emotion words and neutral words in L2 with that in L1, and suggests that the distinction between L2 emotion words and L2 neutral words may be more pronounced, successfully triggering affective priming effects.

From the perspective of the bilingual mental lexicon, the observations of semantic priming effects are consistent with the descriptions of RHM. Apparently, in our experiments, conceptual associations appeared to be more robust in L1 than in L2. For example, semantic priming effects were evident in the Chinese experiment (Experiment I), but not in the English experiment (Experiment II). Although both cross-language experiments (Experiments III and IV) showed semantic priming effects, the effects seemed to be conditional in the L2→L1 direction (English to Chinese), especially when the materials were emotion words. In addition, the results of the difference tests showed that the effect magnitude of Experiment III (Chinese to English) was significantly larger than that of Experiment IV (English to Chinese). This asymmetrical cross-language priming effect is consistent with the assumption that access to the L2 (target) from the L1 (prime) is conceptually mediated. In contrast, the reverse process of accessing the L1 (target) from the L2 (prime) occurs primarily at the lexical level for non-proficient learners, as suggested by the RHM (Dimitropoulou et al., 2011; Keatley et al., 1994).

However, the display of affective associations deviated from the patterns predicted by the RHM. Instead, it appeared to conform to the principles of the DFM. While the DFM is commonly used to explain processing effects related to concrete words, we found that emotion words, despite being perceived as less concrete, exhibited processing advantages over neutral words. This observation led us to infer that cross-language affective attributes are interconnected in a manner similar to conceptual nodes, as depicted in the DFM. When semantic meanings traverse hierarchical links across languages, affective nodes associated with emotion words are activated and propagate along a distinct path, enhancing the affective priming effect.

To some extent, this conclusion is consistent with the Spreading Activation Model (SAM), which depicts a shared network composed of affectively related concepts (Fazio et al., 1986). However, the SAM primarily addresses monolingual issues and does not explain why the effect magnitude of emotion words from L1 to L2 is not consistently larger than that from L2 to L1, as reported in various studies (Ayçiçeği & Harris, 2004; Chan et al., 2006; El-Dakhs & Altarriba, 2018; Ferré et al., 2010; Klauer & Musch, 2003; Ponari et al., 2015).

In general, prevailing models of the bilingual mental lexicon primarily emphasize semantic activation across languages, often neglecting the impact of affective factors. Conversely, models dedicated to affective priming tend to focus on monolingual aspects, thereby overlooking the interplay of cross-language influences and semantic-affective interactions. In light of these limitations, the present study introduces a dual-access construct to illustrate how semantic access and emotional access interact in a mixed-language context.

The construct underscores that semantic access and emotional access operate independently, yet concurrently, and interact with each other. It is therefore aptly referred to as a 'dual-access' construct. Within this framework, semantic access exhibits hierarchical properties, with L1 priming consistently showing greater strength than L2 priming, and L1→L2 priming being stronger than L2→L1 priming, illustrating the hierarchical nature. At the same time, emotional access is depicted as distributed, as indicated by the presence of affective priming effects even when code-switching to a foreign language.

Furthermore, it is important to note that the interaction between semantic priming and affective priming within this construct is mutually facilitative. According to the results of Experiment III, related-emotion pairs yielded significantly faster response times than unrelated-emotion pairs, indicating a cross-language congruency effect in L1 to L2 priming for emotion words. Although the effect was also found for neutral words, it appeared to be much weaker. In Experiment IV, the difference in effect magnitude between emotion words and neutral primes was further amplified, with the congruent priming effect being observed exclusively in emotion words. Given that the primes in this case were in L2, this suggests a greater disparity between emotion words and neutral words in L2 than in L1 in cross-language priming conditions. Meanwhile, the semantic priming effects of emotion words suggest that affective influences facilitate semantic access. Difference tests supported this observation, showing that the effect magnitude of semantic priming was significantly larger for emotion primes than for neutral primes, providing evidence for affective facilitation.

In conclusion, the results of the present study showed that both semantic effects and affective influences can manifest themselves in cross-language priming. It appears that semantic and affective features interact in a facilitatory manner, reinforcing the congruency effects produced by emotion words. Existing classical models fall short in comprehensively explaining the complexity of cross-language priming of emotion words. To address this shortcoming, our study introduces the dual-access construct, which lays emphasis on the mutually facilitative relationship between semantic priming and affective priming.

Conclusions

By analyzing and comparing the experimental results, the present study has led to several notable conclusions.

First, we have shown that semantic and affective priming can exist independently of each other, without adhering to a fixed sequential order. Neither the cognitive primacy nor the affective primacy hypotheses were consistently supported. In particular, the activation of affective attributes verges on an automatic process that is not necessarily dominated by spreading activation in a semantic network. Affective activation tends to be processed through its own network constructed by emotional nodes.

Second, our study showed that both semantic effects and affective influences can manifest themselves in cross-language priming. However, the strengths of the effects depend on the shift of languages and the direction of priming. When semantic and affective influences coincide, they often function interactively, exhibiting mutual facilitation. It is reasonable to infer that the semantic and emotional accesses together contribute to the processing advantages observed for emotion words. The study proposes a novel conceptual framework, termed the 'dual-access' construct, to illustrate the representation of emotion words. This construct emphasizes the independence and distinction between emotional and semantic access while highlighting their interactive and mutually facilitative nature.

Third, we found that emotion words are processed differently within a language as compared to cross-language processing. Specifically, this study argues that the processing advantages of emotion words over neutral words are enhanced in L2, which in turn magnifies their affective influences within the same language.

Finally, the findings support the assumption that Chinese EFL learners have a shared storage for emotion words in the bilingual mental lexicon.[4] Moreover, they are represented in a dual-access mode, characterized by hierarchical semantic access and distributed emotional access.

The implications of our findings are twofold. From a theoretical perspective, our study aimed to provide a theoretical framework for the representation and processing of emotion words, a topic that has been under-theorized in bilingual research. Existing theoretical models have often fallen short in addressing the cross-language representation of emotion words. To fill this gap, our study introduces the dual-access construct, which specifically addresses the cross-language aspects and thus complements existing models that account for affective priming. This construct draws on established models of the bilingual mental lexicon and extends their frameworks to illuminate the unique nature of emotion words.

In practical terms, our findings suggest a shift in instructional priorities when teaching vocabulary. Emotion words, especially in L2, should be emphasized due to their distinct processing advantages. The encoding, storage, and retrieval of emotion words can be highly efficient for language learners. However, the unique nature of emotion words, their differential processing in L1 and L2, and their culture- and language-specific characteristics need to be taken into account when we design tailored approaches to teaching these words. This challenges teachers to navigate the complexities of emotion word instruction and ultimately promote a deeper understanding of language and culture for students.

Several limitations remain in our research design and participant selection. First, the sensitivity of semantic and affective priming to task types requires further investigation of the timing of semantic-affective interactions across a more diverse range of tasks. In addition, intersubject variables such as L2 proficiency and gender differences were not thoroughly examined in our study, and future research should take these variables into account. Finally, the number of items selected for our experiments was relatively small, and expanding the initial corpus search for a broader sample may provide more comprehensive results in the future.

The authors affirm that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional human experimentation committees and with the Helsinki Declaration of 1975, as revised in 2008.

Acknowledgments. This study was supported by the National Social Science Fund of China (No.18AYY026). We would like to express our gratitude to the journal editors and two anonymous reviewers for their insightful suggestions for improvement.

Competing interests. The authors declare none.

Supplementary Material. For supplementary material accompanying this paper, visit http://dx.doi.org/10.1017/S1366728923000895

Notes

1. In the present study, "EFL" is an abbreviation for "English as a Foreign Language".
2. L2 refers to the second language, whereas L1 refers to the first language. For the participants in the present study, their L1 is Chinese, and their L2 is English.
3. Such cases are usually due to participant distraction or temporary technical problems with the programme.
4. The study controlled for the English proficiency level of Chinese EFL learners at an approximate intermediate level. Therefore, this conclusion may vary if participants' proficiency level changes.

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