Psychology Research and Behavior Management

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ORIGINAL RESEARCH

The Influence of Emotional Experience on Semantic Processing of Concrete Concepts

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Introduction: Parallel distributed processing theory (PDP theory) holds that all brain regions involved in conceptual representation perform a series of activities at the same time. However, the role of emotional experience information in concrete conceptual representation is still unknown. This study further explores whether the emotional experience will also affect the semantic processing of concrete concept representations.

Methods: This study used the emotion priming paradigm and semantic judgment task to explore whether emotion priming impacts the processing of animal concepts with different emotional experiences through two experiments. In Experiments 1a and 1b, pleasant or disgusted faces were used as emotional priming stimuli to explore whether the explicit processing of emotions would affect the semantic processing of animal concepts. Experiments 2a and 2b used positive or negative scenery pictures as emotional priming stimuli to explore whether the implicit processing of emotions would affect the semantic processing of animal concepts.

Results: The Experiment 1 results showed that the perception of faces promotes the processing of animal words, showing the "word-emotion congruence effect". Experiment 2a did not show the expected results, while Experiment 2b showed that the general negative perception of scenery pictures could significantly promote the processing of disgusted animal words. The results further proved the "word-emotion congruence effect" shown in the results of Experiment 1 from the perspective of implicit emotion processing. Combining the results of two experiments, it can be proven that emotional experience affects the semantic processing process of concrete concepts.

Discussion: Both Experiment 1 and Experiment 2b of this study show the "word-emotion congruence effect". PDP theory believes that conceptual representation is represented by the activity patterns of billions of neurons distributed in many areas of the brain, and related semantic processing and sensory processing will occur simultaneously. The results of this experiment well support PDP theory.

Keywords: embodied cognition, emotional experience, conceptual representation, explicit emotional priming, implicit emotional priming

Introduction

One of the typical characteristics of human cognition is the ability to form conceptual representation, which enables individuals to integrate external world experience with internal experience.[1] The theory of parallel distributed processing (PDP) was first put forward by Rumelhart and McClelland in 1986 on the basis of previous studies on connectionism, which explained the cognitive process of conceptual representation.[2] PDP theory assumes that cognitive systems consist of thousands of interconnected units, which interact and process information by weighted connections. Units and connections form the structure of the PDP network. PDP theory does not regard concepts as a set of facts or events stored in the brain but a set of relationships when events are acquired in groups or units, and what is stored is the

Received: 18 August 2022
Accepted: 20 November 2022
Published: 13 March 2023

connection established between these units. Concepts are incorporated into the cerebral cortex directly or through the hippocampal system as a change in synaptic connection strength.[3,4]

According to PDP theory, every concept has a distributed representation, which may involve different knowledge fields, and different knowledge fields will activate different brain regions. The representation of concepts needs to be "consistent" among the representations of independent knowledge fields. For example, regarding the concept of animals, since much of our knowledge about animals is based on their appearance, feelings, emotions, etc., it may involve multiple brain regions, such as the visual cortex, orbitofrontal-limbic system, and frontal cortex.[5] This view is also supported by certain studies; when we read or hear language information associated with perception or action, the brain area corresponding to perception or action will also be activated.[6,7] In contrast, when the perceptual channel associated with the concept is activated, the corresponding concept can also be partially activated, which affects the processing of the concept and produces the effect of facilitation or inhibition.[8–10] At the same time, studies on vision, hearing, touch, and other aspects also show that the sensorimotor and conceptual representation systems in the brain partially overlap, so there is a mutual influence between conceptual processing and sensorimotor channel activation.[11–15]

Specifically, concrete and abstract concepts contain linguistic information and experiential information, while experiential information comes from not only the sensory-motor system but also introspective experience, especially emotion.[16] Regarding the relationship between emotion and conceptual representation, some researchers used abstract emotional concepts as experimental materials, and the research results proclaimed that the processing of emotional concepts can shape individuals' recognition of emotional faces.[17] In addition, in a study by Liu et al, researchers used the emotional priming paradigm to explore whether the individual perception of emotional faces with different valences would affect abstract emotional concepts.[18] The experimental results indicated that the perception of emotional faces affected the processing of abstract emotional concepts, and the relationship between them was bidirectional. However, the role of emotional experience information in concrete conceptual representation remains unknown.

Based on the above analysis, we suggest that emotional experience may influence the processing of concepts with emotional information. We intend to use an emotional priming paradigm and semantic judgment task with explicit emotional face pictures (pleasant/disgusted) or implicit emotional scenery pictures (positive/negative) as emotional priming stimuli and animal concept words as probing stimuli to explore whether explicit or implicit emotional priming has an impact on the processing of concepts with different emotional loads.[19,20] In Experiment 1, we assumed that the explicit processing of emotions would affect the conceptual processing of animals with different emotional loads. To further verify the PDP theory, in Experiment 2, we assumed that the implicit processing of emotions would also affect the conceptual processing of animals with different emotional loads. Through the above two series of studies, we jointly explore the role of emotional experience information in concrete conceptual representation.

Experiment 1

Experiment 1 explored whether and how explicit emotional priming affected the semantic processing of concrete concepts.

The experiment was conducted as follows.

Experiment 1a

Purpose of the Experiment

Experiment 1a aimed to determine whether the semantic processing of concrete concepts with different emotional loads would be affected by pleasant emotional faces.

Subjects

Thirty-six college students were randomly selected, and all subjects had corrected or uncorrected vision. Subjects volunteered to participate in the experiment and were given some remuneration at the end of the experiment. The ethics committee of the authors' institution approved this research.

Experimental Design

A 2 (emotional priming: happy, neutral) × 2 (conceptual word: highly pleasant animals (HPA), highly disgusted animals (HDA)) within-subjects design was used in this experiment. The emotion priming paradigm and semantic judgment task were used, and the dependent variable was the reaction time of the semantic judgment task.

Experimental Materials and Procedures

The materials of Experiment 1a included conceptual words and a face picture of emotional priming.

We first selected 80 animal words from the Caiqing Word Stock and then randomly selected 31 subjects who did not participate in the formal experiment to rate the 80 words on a 7-point scale.[21] In the pleasure rating scale, we asked participants, "How much does this animal make you feel pleasant? (on a scale from 1 (almost none) to 7 (very much))". Similarly, in the disgust rating scale, we asked participants, "How much does this animal make you feel disgusted?" (on a scale from 1 (almost none) to 7 (very much)). We only keep the data between the two upper and lower standard deviations to eliminate the extreme values. Finally, according to the pleasure rating scale, 25 animal words with the highest scores were selected as highly pleasant animals (or HPA for short). According to the disgust rating scale, 25 animal words with the highest scores were selected as the highly disgusted animals (or HDA for short). Table 1 shows the mean and deviation of word scoring results. The pleasure degree of the two types of words was analyzed by a related sample *t*-test, and the results showed that there was a significant difference between them ($p < 0.001$). The same results were found for the disgust degree ($p < 0.001$). According to Cai Qing's word frequency standard, the word frequencies of the two kinds of animal words were calculated (HPA: M = 1.98; SD = 0.60; HDA: M = 1.95; SD = 0.56).[21] After that, the word frequencies of the two types of words were analyzed by *t*-test, and the results showed no significant difference ($p = 0.869$). At the same time, 50 common neutral words were selected from the same word stock (word frequency: M = 2.43; SD = 0.18) as irrelevant materials to balance the experiment. Neutral words are words that rate low on the pleasant and disgust scales and arousal scales. Therefore, the semantic judgment task of this experiment contained 100 words, which included 25 HPA, 25 HDA, and 50 common neutral words.

The method of selecting face pictures for emotional priming was as follows: first, 16 happy face pictures (faces expressing happiness) were selected from the Chinese Affective Face Picture System (CAFPS), in which men and women are equally divided. The average recognition rate index corresponding to each emotional picture refers to the percentage of the raters who think that the picture belongs to this emotional type in the total number of raters. The average intensity refers to the raters' rating of the emotional intensity of pictures (7-point rating). According to the existing data in the system, the results showed that the average recognition rate of pictures was 99.15 (SD = 0.93), and the average intensity was 6.75 (SD = 0.34). Then, 16 neutral emotional face pictures were selected, in which men and women were equally divided. According to the existing database in the system, the results showed that the average recognition rate of pictures was 87.13 (SD = 10.54), and the average intensity was 5.86 (SD = 0.17).

In this experiment, E-prime 2.0 was used to compile and present the experimental program. The whole experiment was divided into 8 blocks (4 A blocks, 4 B blocks) and there were 25 trails in each block. In each block, happy face pictures or neutral face pictures were used as emotional priming pictures. ABBA design was used in the experiment to balance the order of emotional pictures. After happy emotional priming and neutral emotional priming, each subject had to perform semantic judgment tasks on Chinese words.

As shown in Figure 1, a fixed point was first presented on the screen for 500 ms in each trial, and then an emotional face was randomly presented for 200 ms. A blank screen would appear for 100 ms after the face was presented. After that, the stimulus words in the semantic judgment task were randomly presented, and the subjects had

Table 1 Mean and Standard Deviation of Word Scoring

Word Type	Degree of Pleasant	Degree of Disgust
HPA	5.80±0.38	1.35±0.26
HDA	5.55±0.89	1.51±0.37

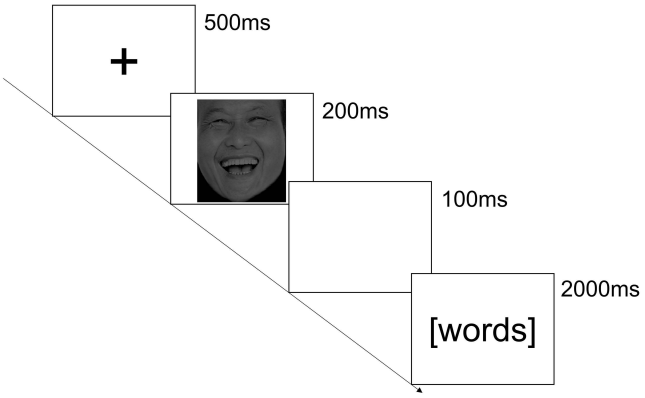

Figure 1 Flow chart of single trial in Experiment 1.

to judge whether the words were animal words or non animal words within 2 seconds. If "Yes", the "F" key was pressed; if "No", the "J" key was pressed. The target stimulus appeared until the subjects responded or disappeared after 2000 ms. There was a 500 ms buffer after word presentation. All subjects had to practice before the formal experiment. The practice block included 12 trials, and the materials used in the practice process did not appear in the formal experiment. To make the subjects carefully observe the pictures and ensure the success of emotional priming, after each block, the subjects would answer a question unrelated to the experiment: "Do you think there were more male faces or more female faces in the series of face pictures that just appeared?" After the subjects made the corresponding judgment, they entered the next block. After the experiment, we collected only the data with the correct responses.

Results and Analysis

Data with more than a 70% correct response rate were considered valid data.[18] All the data were analyzed by IBM SPSS Statistics 25 using ANOVA. The reaction time of semantic judgment tasks is shown in Table 2.

Repeated measures ANOVA of response time in the semantic judgment task showed that the main effect of priming type was not significant [F (1, 35) = 0.025, p = 0.876], and the main effect of word types was not significant [F (1, 35) = 0.617, p = 0.438]. The interaction between priming types and word types was significant [F (1, 35) = 12.24, p = 0.0012, η_p^2 = 0.26].

After that, simple effect analysis for happy emotional priming showed that the reaction time of HPA was significantly faster than that of HDA [F (1, 35) = 13.35, p = 0.001, η_p^2 = 0.28]. However, under the condition of neutral emotional priming, there was no significant difference between the reaction times of HPA and HDA [F (1, 35) = 2.75, p = 0.11]. The above results indicated that happy emotional priming speeded the response to HPAs relative to HDAs.

The results of Experiment 1a showed that happy emotional priming could promote semantic processing of concrete concepts with consistent emotional information more effectively than semantic processing of concrete concepts with conflicting emotional information.

Table 2 Mean and Standard Deviation of Reaction Time of Semantic Judgment Task in Experiment 1a

Emotional Priming Type	HPA	HDA
Happy emotional priming	691.05±143.83	716.39±163.99
Neutral emotional priming	713.60±171.10	698.55±149.84

Repeated measures ANOVA of the accuracy data of each block in Experiment 1a showed no significant difference in the response accuracy of each block ($p > 0.05$), which indicated no trade-off phenomenon of speed-accuracy in semantic judgment tasks in Experiment 1a.

Experiment 1b

The results of Experiment 1a proved the influence of explicit positive emotional priming on the semantic processing of concrete concepts. To further verify the assumption of this study, Experiment 1b changed the happy emotional faces into disgusted emotional faces. If the explicit emotional experience can affect the semantic processing of concrete concepts, then Experiment 1b should have similar results to Experiment 1a.

Purpose of the Experiment

Experiment 1b aimed to determine whether the semantic processing of concrete concepts with happy and disgust loads would be affected by disgusted emotional faces.

Subjects

Thirty college students were randomly selected, and all subjects had corrected or uncorrected vision. Subjects volunteered to participate in the experiment and were given some remuneration at the end of the experiment.

Experimental Design

A 2 (emotional priming: disgusted, neutral) × 2 (conceptual word: highly pleasant animals (HPA), highly disgusted animals (HDA)) within-subjects design was used in this experiment. In this experiment, the emotion priming paradigm and semantic judgment task were used, and the dependent variable was the reaction time of the semantic judgment task.

Experimental Materials and Procedures

The conceptual words of Experiment 1b are the same as those of Experiment 1a.

The method of selecting face pictures for emotional priming was as follows: first, 16 disgusted face pictures (faces expressing disgust) were selected from the Chinese Affective Face Picture System (CAFPS), in which men and women are equally divided. According to the existing data in the system, the results showed that the average recognition rate of pictures was 74.77 (SD = 7.32), and the average intensity was 6.62 (SD = 0.61). The neutral material was the same as in Experiment 1a.

The experimental procedure was the same as in Experiment 1a.

Results and Analysis

Data with a correct response rate of more than 70% were considered valid data. All the data were analyzed by IBM SPSS Statistics 25 using ANOVA. The reaction time of semantic judgment tasks is shown in Table 3.

Repeated measures ANOVA of response time in the semantic judgment task showed that the main effect of priming type was significant [F (1, 29) = 5.84, p = 0.022], and the main effect of word types was significant [F (1, 29) = 6.74, p = 0.015]. The interaction between priming types and word types was significant [F (1, 29) = 5.51, p = 0.026, η_p^2 = 0.16].

After that, simple effect analysis showed that the reaction time of HDA was significantly faster than that of HPA under the disgusted emotional priming condition [F (1, 29) = 19.19, $p < 0.001$, η_p^2 = 0.398]. However, under the condition of neutral emotional priming, there was no significant difference between the reaction times of HPA and HDA

Table 3 Mean and Standard Deviation of Reaction Time of Semantic Judgment Task in Experiment 1b

Emotional Priming Type	HPA	HDA
Disgusting emotional priming	688.14±121.73	657.27±102.73
Neutral emotional priming	705.93±138.09	703.50±155.59

[F (1, 29) = 0.06, p = 0.82]. The above results indicated that disgusted emotional priming promoted the semantic activation of HDA.

The results of Experiment 1b showed that disgusted emotional priming could promote semantic processing of concrete concepts with consistent emotional information, but it did not inhibit semantic processing of concrete concepts with conflicting emotional information.

Repeated measures ANOVA of the accuracy data of each block in Experiment 1a showed no significant difference in the response accuracy of each block ($p > 0.05$), which indicated no trade-off phenomenon of speed-accuracy in semantic judgment tasks in Experiment 1a.

Combining the results of Experiment 1a and Experiment 1b proved that explicit emotional experiences could influence the semantic processing of concrete concepts. In Experiment 1, emotional faces were used as emotional priming stimuli, and the facilitation effect of explicit processing of emotions on concrete concepts supported the view of embodied semantics. Furthermore, in Experiment 2, implicit positive/negative emotional pictures were used as emotional priming stimuli to explore whether implicit emotional processing would affect the semantic activation of concepts with different emotional loads.[22]

Experiment 2

Experiment 2 explored whether and how implicit emotional priming affected the semantic processing of concrete concepts. Experiment 2 used the same procedures and stimuli as in Experiment 1, and the explicit emotional priming materials were changed into implicit positive and negative scenery pictures rather than emotional face pictures.

The experiment was conducted as follows.

Experiment 2a

Purpose of the Experiment

Experiment 2a aimed to determine whether the semantic processing of concrete concepts with happy and disgust loads would be affected by positive scenery pictures.

Subjects

Twenty-eight college students were randomly selected, and all subjects had corrected or uncorrected vision. Subjects volunteered to participate in the experiment and were given some remuneration at the end of the experiment.

Experimental Design

A 2 (emotional priming: positive, neutral) × 2 (conceptual word: highly pleasant animals (HPA), highly disgusted animals (HDA)) within-subjects design was used in this experiment. In this experiment, the emotion priming paradigm and semantic judgment task were used, and the dependent variable was the reaction time of the semantic judgment task.

Experimental Materials and Procedures

The conceptual words used in Experiment 2a were the same as those used in Experiment 1a.

The method of selecting scenery pictures for emotional priming was as follows: first, 16 positive scenery pictures were selected from the Chinese Affective Face Picture System (CAFPS), in which men and women are equally divided. According to the existing data in the system, the results showed that the average valence rate of pictures was 7.08 (SD = 0.51), and the average arousal degree was 5.49 (SD = 0.52). Then, 16 neutral emotional scenery pictures were selected, in which men and women were equally divided. According to the existing database in the system, the results showed that the average valence rate of pictures was 5.21 (SD = 0.54), and the average arousal degree was 3.57 (SD = 0.23). A paired sample t-test was carried out on the valence and arousal of the two kinds of scenery pictures, and the results showed that there was a significant difference in valence between the two kinds of pictures (t = 8.858; $p < 0.001$), and there was also a significant difference in arousal degree (t = 12.163; $p < 0.001$).

The experimental procedure of Experiment 2a was the same as that of Experiment 1. To ensure the success of emotional priming, the subjects were asked to answer a question unrelated to the experiment after each block: "Of the series of pictures that just appeared, how many were repeated?" After the subjects made the corresponding judgment, they would enter the next block. After the experiment, we collected only the data with the correct responses.

Results and Analysis

Data with a correct response rate of more than 70% were considered valid data. All the data were analyzed by IBM SPSS Statistics 25 using ANOVA. The reaction times of semantic judgment tasks are shown in Table 4.

Repeated measures ANOVA of response time in the semantic judgment task showed that the main effect of priming type was not significant [F (1, 27) = 0.001, p = 0.981], and the main effect of word types was not significant [F (1, 27) = 0.404, p = 0.530]. The interaction between priming types and word types was also not significant [F (1, 27) = 1.508, p = 0.230]. Experiment 2a did not show the expected results.

Repeated measures ANOVA of accuracy data of each block in Experiment 2a showed no significant difference in the response accuracy of each block ($p > 0.05$), which indicated that there was no trade-off phenomenon of speed-accuracy in semantic judgment tasks in Experiment 2a.

The unexpected results in Experiment 2a may be caused by the low arousal degree of the positive scenery pictures. Previous studies have indicated that the arousal of emotional pictures affects the processing of picture materials.[23] Second, individuals have negative memory bias toward emotional material processing, which shows that negative information has deeper coding information and lower recognition standards.[24] In Experiment 1, we found that the facilitation effect of disgusted emotional priming on highly disgusted words ($p < 0.001$) was more significant than that of pleasant emotional priming on highly pleasant animals (p = 0.008). In our opinion, the results of Experiment 2a are not sufficient to prove whether implicit emotional experience affects the semantic processing of concrete concepts. Therefore, it is necessary to further explore the influence of implicit negative scenery pictures as emotional priming stimuli on concrete concept processing.

Experiment 2b

Purpose of the Experiment

Experiment 2b aimed to determine whether the semantic processing of concrete concepts with happy and disgust loads would be affected by negative scenery pictures.

Subjects

Thirty college students were randomly selected, and all subjects had corrected or uncorrected vision. Subjects volunteered to participate in the experiment and were given some remuneration at the end of the experiment.

Experimental Design

A 2 (emotional priming: negative, neutral) × 2 (conceptual word: highly pleasant animals (HPA), highly disgusted animals (HDA)) within-subjects design was used in this experiment. In this experiment, the emotion priming paradigm and semantic judgment task were used, and the dependent variable was the reaction time of the semantic judgment task.

Table 4 Mean and Standard Deviation of Reaction Time of Semantic Judgment Task in Experiment 2a

Emotional Priming Type	HPA	HDA
Positive emotional priming	639.68±119.57	628.14±107.56
Neutral emotional priming	631.44±104.80	635.74±106.87

Experimental Materials and Procedures

The conceptual words used in Experiment 2b were the same as those used in Experiment 1a.

The method of selecting scenery pictures for emotional priming was as follows: first, 16 negative scenery pictures were selected from the Chinese Affective Face Picture System (CAFPS), in which men and women are equally divided. According to the existing data in the system, the results showed that the average valence rate of pictures was 2.32 (SD = 0.28), and the average arousal degree was 5.88 (SD = 0.78). Then, 16 neutral emotional scenery pictures were selected, in which men and women were equally divided. According to the existing database in the system, the results showed that the average valence rate of pictures was 5.21 (SD = 0.54), and the average arousal degree was 3.57 (SD = 0.23). A paired sample *t*-test was carried out on the valence and arousal of the two kinds of scenery pictures, and the results showed that there was a significant difference in valence between the two kinds of pictures ($t = -18.40$; $p < 0.001$), and there was also a significant difference in arousal degree ($t = 11.67$; $p < 0.001$).

The experimental procedure of Experiment 2b was the same as that of Experiment 2a.

Results and Analysis

Data with correct response rates of more than 70% were considered valid data. All the data were analyzed by IBM SPSS Statistics 25 using ANOVA. The reaction times of semantic judgment tasks are shown in Table 5.

Repeated measures ANOVA of response time in the semantic judgment task showed that the main effect of priming type was significant [F (1, 29) = 0.363, $p = 0.552$], and the main effect of word types was significant [F (1, 29) = 0.431, $p = 0.516$]. The interaction between priming types and word types was significant [F (1, 29) = 9.860, $p = 0.004$, η_p^2 =0.25].

After that, simple effect analysis showed that the reaction time of HDA was significantly faster than that of HPA under the negative emotional priming condition [F (1, 29) = 5.49, $p = 0.026$, η_p^2 =0.159]. However, under the condition of neutral emotional priming, there was no significant difference between the reaction times of HPA and HDA [F (1, 29) = 0.90, $p = 0.35$]. The above results indicated that negative emotional priming promoted the semantic activation of HDA.

The results of Experiment 2b showed that negative emotional priming could promote semantic processing of concrete concepts with consistent emotional information, but it did not inhibit semantic processing of concrete concepts with conflicting emotional information. The results of Experiment 2b are consistent with expectations.

Repeated measures ANOVA of accuracy data of each block in Experiment 1a showed no significant difference in the response accuracy of each block ($p > 0.05$), which indicated that there was no trade-off phenomenon of speed-accuracy in semantic judgment tasks in Experiment 1a.

On the basis of Experiment 1, Experiment 2 used implicit positive/negative scenery pictures as emotional priming stimuli to explore the influence of implicit emotion processing on the conceptual processing of concrete concepts with different emotional loads. Although Experiment 2a did not produce the expected results, the results of Experiment 2b showed that implicit processing of negative emotions would promote the processing of concrete concepts with negative emotional experiences. This further proved that implicit emotional experience could influence the semantic processing of concrete concepts and support embodied cognition theory.

Table 5 Mean and Standard Deviation of Reaction Time of Semantic Judgment Task in Experiment 2b

Emotional Priming Type	HPA	HDA
Negative emotional priming	699.04±153.87	680.36±151.3
Neutral emotional priming	693.48±138.14	702.32±150.74

Discussion

Experiment 1 and Experiment 2 discussed the influence of emotional experience on semantic processing of specific concepts from explicit and implicit perspectives, respectively. The experimental results showed a "word-emotion congruence effect", which indicated that word processing and emotion processing have overlapping neural mechanisms. The experimental results supported the PDP theory.

The Influence of Explicit Emotional Experience on Semantic Processing of Concrete Concepts

Experiment 1 used specific and explicit emotional faces as emotional priming stimuli, and the results showed that explicit processing of emotions could promote concrete concepts containing consistent emotional experience information. According to the viewpoint of PDP theory, the concept in human cognition is based on the same sensory and motor systems used by individuals when they experience the world.[25,26] The results of this study once again confirm that conceptual processing involves specific language processing brain areas and other systems.[27–30]

The processing of emotional concepts will also promote the recognition of faces with consistent emotions; that is, the influence between emotional concepts and emotional face recognition is bidirectional.[18] Similarly, the results of this study proved that the explicit activation of emotions could promote the semantic processing of specific concepts with consistent emotional information. The experimental results were completely consistent with PDP theory, which strongly supported this theory.

The Influence of Implicit Emotional Experience on Semantic Processing of Concrete Concepts

Based on Experiment 1, this study further explored whether the implicit processing of emotional experience would also affect the processing of concrete concepts. Experiment 2a found no results similar to those of Experiment 1a. However, Experiment 2b found that when the general negative scenery pictures were used as the emotional priming stimuli, they promoted the processing of highly disgusted animals. The results showed that the implicit processing of negative emotions would also affect the processing of concrete concepts.

In this study, the expected results that did not appear in Experiment 2a may be due to the low arousal degree of the positive scene pictures. Previous studies have shown that the arousal degree of stimulation influences the effect of emotional memory of stimulation.[31,32] In Experiment 2 of this study, to exclude the influence of explicit emotional faces, implicit positive and negative scenery pictures without emotional face elements were selected as emotional priming stimuli. Compared with emotional pictures containing emotional face elements in the same database, the arousal degree of positive scenery pictures is lower. Indeed, in Experiment 2, positive and negative emotion pictures showed a notable trend toward significance in arousal degree ($t = -2.026$, $p = 0.061$). Moreover, many previous studies have shown that individuals tend to be biased in recognizing negative emotional information; that is, they are more sensitive to negative information.[33,34] Under the condition of the same cognitive resources, the activation level of negative information is higher, and there is deeper processing in the coding and extraction stages.[24] Another possible explanation is that in positive emotion processing, the representation of set encoded in the connection between the orbitofrontal-limbic system responsible for emotion processing and the hippocampus system responsible for conceptual processing is very specific. Based on the above analysis, it is reasonable to believe that negative emotional experience affects the processing of concrete concepts in an implicit form.

Limitation

The experimental results showed the "emotion-word congruence effect" in two dimensions of explicit and implicit emotional processing.[35] This provided evidence for proving that the processing of concrete concepts would be influenced by individual emotional information. Certainly, this study is only a preliminary discussion at the behavioral level, and research on whether emotional information can influence the conceptual representation of concrete concepts needs further in-depth research to obtain more evidence. In addition, the results of this study showed that implicit emotional

processing only affected the processing of specific concepts in negative situations, but it had no effect in positive situations. What is the specific reason for this result? Further research is needed to confirm this hypothesis.

Conclusion

In this study, we used the emotional priming paradigm to explore whether explicit/implicit processing of emotional experience affected semantic processing of concrete concepts containing emotional experience information. The conclusions of this study include the following two points: (1) The explicit emotional experience will affect the semantic processing of concrete concepts. (2) An implicit negative emotional experience will affect the semantic processing of negative concrete concepts. Based on previous studies, the results of this study demonstrated that the neural mechanisms of conceptual and emotional processing of concepts also overlap, which supports parallel distributed processing theory.

Ethical Statement

The experimental protocols were approved by the Human Research Ethics Committee for Non-Clinical Faculties of the School of Psychology, South China Normal University. Informed consent was obtained from all subjects. This study complied with the Declaration of Helsinki.

Acknowledgments

This work was supported by grants from the MOE Project of Key Research Institute of Humanities and Social Sciences in Universities (Grant number 14th Five-Year Plan) and the National Social Science Foundation (Grant number 19ZDA360).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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