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Discrimination of Positive Facial Expressions is More Susceptible to Affective Background Scenes

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Abstract. Emotional scenes can pass on different messages about environmental factors and generate cognitive impact. In the present study, we investigate how the environmental backgrounds impact the discrimination of facial expressions. First, we built an affective image system based on Minnesota Multiphasic Personality Inventory, called ThuPIS, from which the emotional scenes were selected. Then we designed two experiments to discuss this problem. In the two experiments, positive/negative facial expressions were paired with these emotional positive/negative backgrounds, which were displayed simultaneously with or before the target face. In both experiments, the results show an overall trend that responses for negative facial expressions take longer than positive facial expressions. The comparison between two experiments indicates that a prior display of emotional background scenes accelerates the responses for positive facial expressions more than negative ones. In conclusion, our results suggest that the emotional background scenes have a significant influence on the cognition response time of positive facial expressions.

Keywords: Emotion, Emotional Scenes, Facial Expressions, Contextual Influence, Cognition.

1. Introduction

Psychological status is relative to the attention to the environment, which is affected by the emotion system, and the perception of the environment, which is modulated by the cognitional function. Traditionally, psychologists make a diagnosis on the basis of conversations with and the observation of subjects and the Self-Assessment Manikin (SAM) submitted by the patients. The procedure of evaluating a patient's status can be time consuming, and the results mainly depend on the experiences of the psychologists. Recent studies both on psychology and neuroscience reveal that there is a substantial interaction between the behavioral system and image cognition. Attentional bias has proven to be one of the most important factors in initial processing [1]. To understand how attentional bias may influence cognitional process, psychologists recorded keyboard reaction time (KPTs) and used different types of stimuli.

In the present study, we chose images expressing emotional scenes as background and eigenfaces with different expressions for the foreground to examine the various reaction times of participants, to evaluate how environment affects cognitive process. Emotional faces could be used as a probe cue to detect generalized anxiety disorder (GAD) [2], further study presented a view that there is an orienting of attention to emotional faces during states of anxiety [3]. Masked, angry faces were used in the emotional Stroop task to demonstrate that a Behavioral Activation System (BAS) rather than a Behavioral Inhibition System (BIS) generates the attentional bias for threat [4]. Utilizing the method of dot-probe, delayed disengagement could be activated by emotional faces [5]. In a word, emotional faces proved to act as stimuli during the detection of attentional bias in different ways. On the other hand, it has been shown that image affective systems provide strong support in emotional detection, that is, images have been used as cues to detect s subject's emotions. In order to provide images that more relevant to psychological problems and could evocate emotions more effectively, we built a new image system based on Minnesota Multiphasic Personality Inventory (MMPI), a widely used personality test.

Many studies have learned about the discrimination of facial expressions, and traditional facial expression recognition was used to be investigated by presenting isolated facial expressions [6]. One point is that negative information slows an individual's cognitive speed. When negative facial expressions were

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presented, tasks took longer than when positive or neural facial expressions were shown [7], which suggests that negative faces were more effective in capturing attention than neural or positive faces.

When facial expressions were put into background contexts, the emotional factors that affect the cognition process become more complicated because of the interaction between facial expressions and backgrounds. Studies have shown that the response times for facial expression discrimination were again longer when the facial expressions were incongruent with the emotions of background scenes [8], [9]. These results suggest that the discrimination of facial expression may also relate to the emotional congruency when there is a visual competition between the background and the target. However, this congruency effect relies on the rapid global perception of the face-scene compounds, and can only be observed with positive facial expressions when participants were given enough time to make discrimination [7], [10].

However, practical experience suggests that before facial expressions are presented, people may already have a prior knowledge of the background surroundings, but when facial expressions and background scenes are presented together, there is more a competition effect between the backgrounds and the targets. In the present study, however, we were more concerned on how the cognition process of facial expressions will be influenced when participants have already received a previous cognition of the background scenes. In order to provide images that more relevant to psychological problems and could evocate emotions more effectively, a new image system was built. Then we designed the experiment, in which the participants were forced to view the background before the target facial expressions' appearance, in order to promise a prior cognition process of the background scenes. Another experiment presenting target facial expression simultaneously with the background scene was also conducted in order to make a comparison. We hypothesize that the only effective variable between the two experiments is the time displaying target facial expression. In both experiments, the task was to categorize the facial expressions into positive or negative, and the response time and error rates were recorded. We hypothesize that the emotional congruence of facial expression can help improve the discrimination of facial, and the pre-presentation of scene context can also accelerate the cognition process.

2. Materials

2.1. A Novel Affective Image Database: ThuPIS

Emotional scenes for psychological use are usually diverse from different experiments according to different affiliations. The lack of high-quality general affective image database makes it difficult to evaluate results of different experiments, and lead to a given problem that how to choose affective images as background scenes in our experiments.

As far as we know, the most widely used psychological affective image system is the International Affective Picture System (IAPS). Pictures in this system cover a variety of themes and were all rated three affective dimensions, which are pleasure, arousal and dominance [11]. But the low resolution and prominent characteristics of western culture frustrate IAPS being used in our experiment facing Chinese subjects. Thus we built a novel affective image system, called ThuPIS, from which we select emotional scenes as backgrounds.

The process of building ThuPIS is essentially to establishing a correspondence between the MMPI and an ontology of images. MMPI is a classical personality test in the diagnosis of mental health, and consists of 567 items related to daily life. These items provide us things and scenes more relevant to one's psychological status in everyday life, and images with these themes are considered more emotionally evocative. First, semantic elements expressing things or scenes were extracted from MMPI. These semantic elements containing words and phrases constitute the elementary themes of images. Then the hierarchical structure of ThuPIS is constructed by classifying and re-arranging these semantic elements. Eight basic classes (physical state, Psychological state, Social relation, World view, Self and social acknowledgement, Synthetic factors, Sex, Activity and interest) were finally generated by analyzing MMPI according to the work in [12]. Finally, images corresponding to the themes extracted from MMPI were collected. This process is illustrated in Figure 1. Additionally, the affective attributes of images in ThuPIS were evaluated by rating experiments. A

9-point scale Self-Assessment Manikin was used for rating, and images were finally labeled as emotional positive, neutral or negative according to the score.

The new affective image system ThuPIS provides an ontology of emotionally evocative color images, whose themes are derived from MMPI. It follows a hierarchical structure and provides images with specific psychological topics and affective attributes very conveniently. Up to now, there are totally 865 affective images covering 326 MMPI items in ThuPIS, and this scale will always be enlarged.

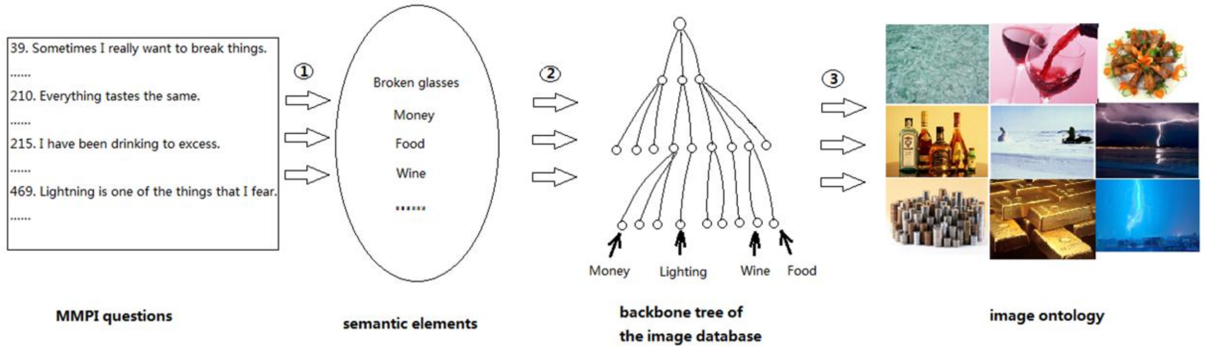


Fig. 1: The process of building ThuPIS

2.2. Target Facial Expressions

As real faces usually indicate ethnic or cultural factors, which may confuse the facial expression itself, eigenfaces, which only maintained main facial features, were used in the current study to help reduce the influence from participants' personal preference [13]. Finally, four positive and four negative facial expressions were generated from the facial expression databases, including Cohn-Kanade, JAFFE, TFEID, FRGC v2.0, AR, and Feedtum. These facial expressions are displayed in Figure 2.

Fig. 2: Facial expressions generated from different facial expression databases using feature-based techniques.

2.3. Face-Scene Compounds

Finally, 30 positive images and 30 negative images were selected from the new affective database ThuPIS as background scenes. Each of the scenes were randomly paired with one positive eigenface and one negative eigenface, which consists of our experiment materials of 120 fixed face-scene compounds.

3. Experiments

Two experiments based on the face-scene compounds mentioned above were designed to evaluate how environmental affects cognitive process of facial expressions. Figure 3 shows the overall difference between the general procedures of these two experiments.

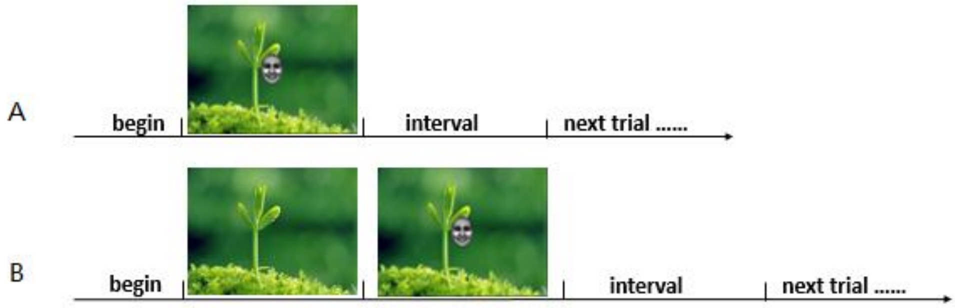


Fig. 3: Comparison of procedures of two experiments

3.1. Experiment A

Participants. Twenty-five university students (9 females and 16 male, mean age = 23.12, SD = 1.166) participated in the experiment. All participants had normal or corrected-to-normal vision and reported no history of neurological problems. Only right-handed participants were accepted. Informed consent was obtained from each participant. Participants were paid 30 RMB for their participation.

Procedure. First of all, participants were informed orally and in writing that they would view a series of images with an emotional background scene and a target face with a positive or negative expression at the center. Their task was to categorize the facial expressions into positive and negative as quickly as possible, which means that the participants were given ample time to respond. Between each trial, there was a blank period of 2000ms. Half of the participants were asked to press 'F' for positive facial expressions, and 'J' for negative facial expressions. Another half were inversed. Stimulus materials were presented on a 20-inch laptop computer, which was at a distance of 60 cm from the participants. All background scenes were displayed on a black surround with a size of 21.5cm×28.7cm (20.3°×26.9°), while facial expressions were displayed at a size of 5.3cm×4.2cm (5.1°×4.0°).

Each experiment was composed of 8 trials and 112 formal trials, and the sequence to display face-scene compounds was randomly generated. The participants were able to choose a break during the experiment to avoid fatigue. Participants' reaction time and accuracy were recorded.

Results. In this experiment, the error rates were less than 5% on average. Our main interest was the response time for the discrimination of facial expression when the context, which is the background scene, and the target eigenface were presented at the same time.

The analysis of response times indicated that the responses for positive facial expressions paired with positive scenes were significantly faster than all of the other compounds [$t(24) = 2.79$, $p < 0.01$, $d = .56$ when compared with negative facial expression – negative scene; $t(24) = 2.62$, $p < 0.02$, $d = .52$ when compared with negative facial expression – positive scene; $t(24) = 2.85$, $p < 0.01$, $d = .57$ when compared with positive facial expression – negative scene]. A significant main effect was found for facial expressions in positive scenes [$F(1, 24) = 8.127$, $p < 0.01$]. The difference between the responses of negative facial expression paired with negative scene and negative facial expression paired with positive scene was not significant [$t(24) = 0.23$, $p > 0.5$]. The congruency effect was not observed when the participants took their time responding. The mean response time of each conditions was shown in Figure 4(a).

3.2. Experiment B

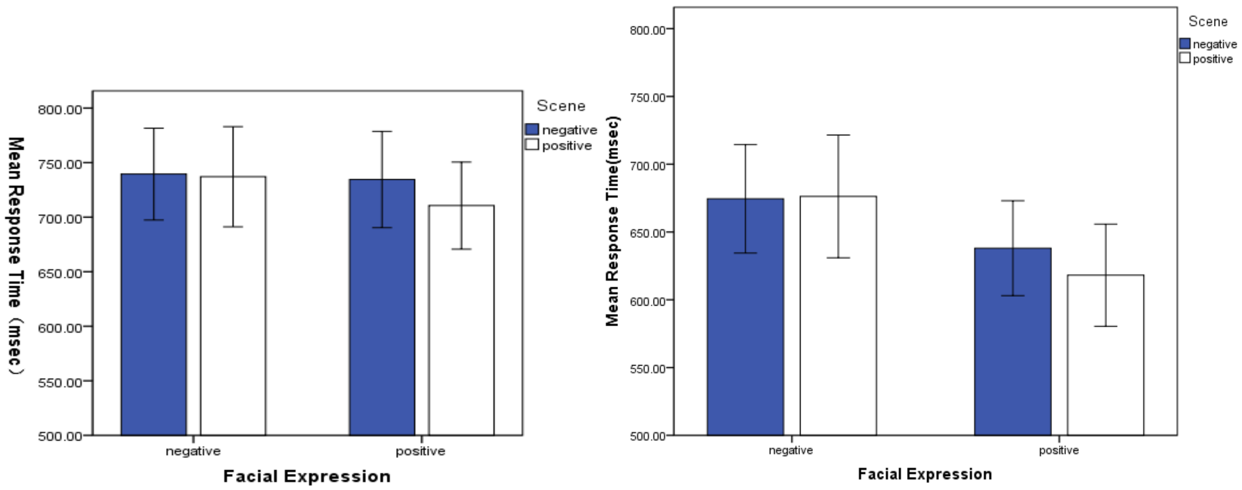
Participants. Experiment B was conducted two weeks after Experiment A with the same participants.

Procedure. The general procedure in Experiment B is similar to that in Experiment A. The only difference is that in Experiment A, the background scene and the target eigenface are presented together, while in Experiment B, the background scene is displayed before eigenface, which promise a prior cognition process of the background scene.

Results. In this experiment, the rate of error responses was low, at less than 5% on average. Similar to Experiment A, we were mainly concerned with the response time when the participants had already been shown the emotional scenes to arouse a corresponding emotion.

By analyzing the response times, we found a significant main effect for facial expression in both positive scenes [F(1,24) = 11.29, p < .005] and negative scenes [F(1,24) = 5.66, p < .05]. The responses for positive facial expressions were significantly faster than negative facial expressions in positive scenes [t(24) = 3.36, p < .005, d = .67] and negative scenes [t(24) = 2.38, p < .05, d = .48]. However, a significant main effect for scenes was only found in positive facial expressions [F(1,24) = 7.51, p < .05]. Although positive facial expressions produced significantly shorter response time when paired with positive scenes than when paired with negative scenes [t(24) = 2.74, p < .02, d = .55], the difference between the negative facial expressions paired with positive scenes and negative scenes was not significant [t(24) = 0.135, p > .5]. The mean response time of each condition was shown in Figure 4(b). The scenes only influence the discrimination process of positive facial expression. Besides, responses for positive facial expressions paired with positive scenes were significantly faster than that for negative facial expressions paired with negative scenes [t(24) = 3.55, p < .002, d = .71], and responses for positive facial expressions paired with negative scenes were also significantly faster than that for negative facial expressions paired with positive scenes [t(24) = 2.37, p < .05, d = .47]. The congruency effects were also not observed.

When compared with Experiment A, the response times for each face-scene compounds were significantly shorter [t(24) = 3.64, p < .001, d = .73 for negative-negative face-scene compounds; t(24) = 6.58, p < .001, d = 1.31 for positive-negative face-scene compounds; t(24) = 4.16, p < .001, d = .83 for negative-positive face-scene compounds; t(24) = 8.27, p < .001, d = 1.65 for positive-positive face-scene compounds]. The results suggested that showing the context (the background scenes) prior to the target face can help participants' discrimination of facial expressions. Besides, a main effect of facial expressions was found [F(1,49) = 6.94, p < 0.02], which shows that responses for positive facial expressions (with a mean acceleration of 94.5 ms, SEM = 9.1 ms) accelerated more than negative facial expressions (with a mean acceleration of 64.6 ms, SEM = 11.4 ms). However, the influences from the emotional information of scenes did not have any significant difference.



(a) (b)

Fig. 4: Results of Experiment A and Experiment B

4. General Discussion

One possible interpretation to our results is that negative facial expression constraints the participants' attention to surrounding contexts, which serve as an accompanying factor to the tasks [7]. However, this interpretation fails to explain the results in Experiment B that when given a prior presentation of positive/negative scenes, which promises a brain's process of scenes and forces a congruency or incongruency emotion before the target face is shown, responses for negative facial expressions again had no difference. An early study has shown that the congruency effects could be observed only when a rapid show of the stimulus composed of scene and facial expressions [10], and this indicates that the discrimination of facial expressions may be affected by the emotional information from scenes very rapidly [8], [14]. However, our results also suggest that it is an extremely short time for people to fascinate their attention onto the negative facial expression from context.

Another possible mechanism to explain our results is that the response is related to the conflict emotional information. When the emotion expressed by the target facial expression is congruent with that expressed by context, the emotional information needed to be processed is simple, thus participants make fast responses to the task; otherwise, the emotional information becomes more complex, and participants make slow responses. According to this point, the results would tend to be that the responses for compounds with congruency emotion would be faster than others with incongruency emotion. But the results of the two experiments just do not support this idea, which suggests that it is really the negative information rather than the emotional conflict that acts as the main factor during the cognition process of facial expression, when participants are given enough time to make a decision.

The comparison between Experiment A and Experiment B indicates an overlap between the cognition process of facial expressions and emotional scenes, which constraints the performance of facial expression categorization in emotional background scenes. The appearance that the performance improvement in Experiment B relates to the emotion of facial expressions more than the scenes suggests that the cognition of positive facial expressions is more susceptible to the emotional backgrounds. When only the results of positive facial expressions are considered, there seems to be a secondary effect from the emotional conflict. However, this supposedly needs more evidence from event-related potential studies and neural image studies.

5. Conclusion

In this paper, we try to address the problem on how emotional scenes influence the discrimination of facial expressions in the present study. First, we built a novel affective image system according to MMPI, in order to provide affective images considered more relevant to one’s psychological status. Then based on the image system, two experiments were designed. The response times for categorization of facial expressions were recorded, and the results show that emotional scenes have a significant influence on positive facial expression, and the comparison between two experiments suggests that the presentation of scenes before target faces accelerates responses for positive facial expressions more than negative facial expressions. The overall trend in the two experiments is that responses for negative facial expressions take longer than positive ones. In summary, our results suggest that the cognition of positive facial expressions were more easily affected by emotional backgrounds, while the cognition of negative facial expressions was more stable and less susceptible to the emotional context.

6. Acknowledgements

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7. References

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