Do Different Emotional Valences Have Same Effects on Spatial Attention?

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Abstract—**Emotional stimuli have a priority to be processed relative to neutral stimuli. However, it is still unclear whether different emotions have similar or distinct influences on attention. We conducted three experiments to answer the question, which used three emotion valences: positive, negative and neutral. Pictures of money, snake, lamp and letter x were used as stimuli in Experiment 1. In Experiment 2A, schematic emotional faces (angry, smile and neutral face) were used as experimental stimuli to control the stimuli complexity. In Experiment 2B, stimuli were three line drawing pictures selected from the Chinese Version of Abbreviated PAD Emotion Scales, corresponding respectively to anger, joy and neutral emotion. We employed the paradigm of inhibition of return (IOR, an effect on spatial attention that people are slow to react to stimuli which appear at recently attended locations, cf. Posner & Cohen, 1984) which used exogenous cues and included 20% catch trials. Seventy-four university students participated in the experiments. We found that participants needed more time to process negative emotional pictures (Exp1, 2A&2B), and the effect of IOR could happen at the ISI (interstimulus interval) as short as 50ms (Exp1). Meanwhile, the data demonstrated that IOR happened at 50ms ISI only when the schematic face was angry, and RTs of angry schematic faces were significantly longer than RTs of the other two faces (Exp2A). We further found that the expectancy might play a role in explaining these results (Exp3). In all three experiments, we found consistently there was a U-shaped relationship between RT and ISI, irrespective of the cue validity and emotional valence. These results showed that different emotional valences had distinct influences on attention. To be specific positive and neutral emotions could be processed more rapidly than the negative emotion.**

Keywords-emotional valences; spatial attention; IOR; schematic face; PAD Emotion Scales.

I. INTRODUCTION

From the evolutionary perspective, emotion and attention are both important for survival. Our emotional responses to objects and events tell us what are beneficial or potentially harmful. The happiness is experienced when seeing a pile of money; in contrast, the fear is evoked when encountering a snake. Meanwhile, attention can enhance the processing of relevant information and suppress the processing of irrelevant information. Both of emotion and attention had been often considered as separated. However, recent research found they may interact with each other[1]. The emotional pronounced events may influence attention, which could ensure that motivationally relevant information received preferential processing. Indeed, there is now much evidence showing that emotion can modulate attentional processing. However, it is still unclear whether different emotions have similar or distinct influences on attention.[2].

People's ability to orient visual attention to various locations and objects in the environment is crucial to them, attentional orienting has been attracted a considerable amount of research interest[3-4]. The classical experiment paradigm of attentional orienting is spatial cuing which was reported firstly by Posner and Cohen[3]. They noted that when an abrupt peripheral visual stimulus, called the "cue," precedes the presentation of a forthcoming visual target, target detection response time (RT) will be speeded when the cue–target stimulus onset asynchrony (CTOA or SOA) is short (less than 150 ms) and the RTs will be slowed when the CTOA is long (300 ms or more). This phenomenon was termed inhibition of return (IOR) and has fostered a mountain of research since its first appearance[5]. But it is far from reaching the consensus what the mechanism of IOR is (for example, Sumner, P.[6], see general discussion).

We now know that attention is influenced not only by stimulus location but also non-spatial attributes such as color and shape[7] in spatial cueing paradigm. And recent research found emotionally salient stimuli also could have impact on attention[1]. Will this *repetition disadvantage* (considering there is no consensus about what is the mechanism of IOR, we use the theoretically neutral term *repetition disadvantage* suggested by Fox, E. and J.W. de Fockert[7]) be the same to all emotional valences?

II. EXPERIMENTS 1

The aim of this experiment was to examine whether there are different influences of emotional valences on attention.

A. *Method*

1) Participants.

Forty university students attended the experiments and each of them received RMB 10 Yuan for participating. All the participants reported normal or corrected-to-normal vision. None was aware of the purpose of the experiment.

2) Apparatus and Stimuli.

A Lenovo computer with a 17' CRT monitor running at a refresh rate of 75Hz and the software package E-Prime (version 1.1) were used for stimuli presentation and data collection.

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The target stimuli are pictures of money of 100 Yuan, snake, neutral photo and letter "x". All stimuli were presented on a silver gray background.

3) Procedure.

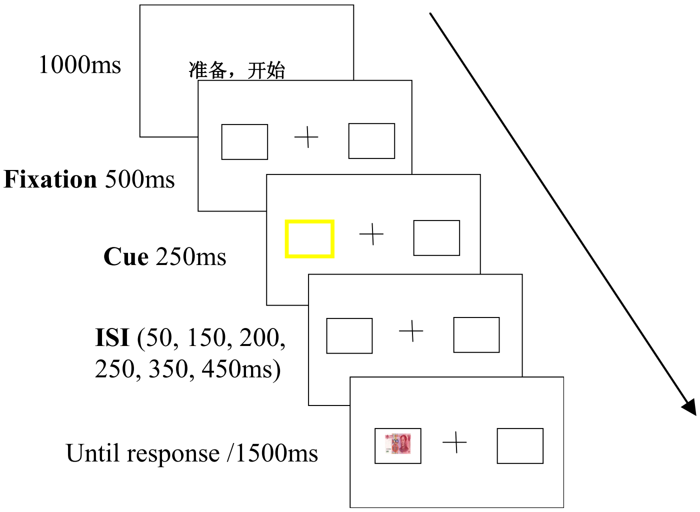

Figure 1. The trial sequence used in Experiment 1.The peripheral cue and the target could appear to the right or left of fixation. Subject fixates at central +".The figure is not drawn to scale. Reaction time (RT) was measured for keypress responses for detecting a target at a peripheral location. The target was preceded by a cue, which directed attention either to the target location (valid cue) or to the wrong location (invalid cue)

The experiment was conducted at a sound-attenuated, dimly lit room. Participants were seated approximately 45 cm from the screen.

The sequence of events on each trial is shown in Figure 1. Each trial began with a "Get ready" warning for 1000 ms, followed by a "+" (subtending 0.8° of visual angle) together with two boxes (about 5° to the right or left of the fixation) for 500 ms. Participants were instructed to fixate on the plus sign. Then one of the two boxes became yellow for 250 ms to cue one of the possible locations where the target might appear. It is assumed that this abrupt onset of the cue will capture attention to that location[8], which was referred to as the "cued location." Following the cue, the fixation and the boxes remained on the screen for 50, 150, 200,250, 350, or 450 ms. The target was then presented in one of the two boxes. Participants were required to made a detection keypress to indicate the presentation of the target as quickly and accurately as possible. If no response was made within 1,500 ms the next trial began. On 20% trials (catch trail) there were no targets. All possible combinations of the cue location and target location were presented randomly.

B. Design

In Experiment 1, a 4 × 6 × 2 mixed factorial design was employed, with type of target stimuli as between-subjects factor with four levels: pictures of money, snake, lamp or letter "x". ISI and cue validity were manipulated as within-subjects variables. ISI had six levels: 50, 150, 200,250, 350, or 450 ms. Cue validaty with two levels: valid (target and cue presented at the same box) or invalid (target and cue appeared at different boxes). The presentation order of all tials were randomized. Before the experimental trials subjects received a block of 24 practice trials (one trial for each combination of cueing x ISI, plus12 catch-trials). At the end of practice trial participants were given a value of accuracy to assure their understanding of the task. The formal experimental block of one type of stimuli consisted of 240 trials. Thus, the whole experiments had 1056 (96+960) trials.

C. Results

Participants' responses which were faster than 100ms or slower than 1000ms, and trials on which an error was made, were excluded from further analysis. A mixed-design analysis of variance (ANOVA) was used to analyze the RT data.

The mean RTs for the four types of stimuli are presented in Figure 2. There was a main effect for ISI [F (5,165) =9.774, *p*<. 004]. The main effect for stimuli type was not significant [F (3, 33) =1.7, *p*=.186]. As we can see from Figure 2, the attentional processing of picture of snake was slower than the other three types of pictures. Thus, we conducted a paired comparison analysis for pairs of snake-money, snake-lamp, and snake-x. We found that the mean RT of snake picture was very significantly longer than the RTs of all other pictures [*ps*<.01]. Regarding the effect of IOR, RTs of invalid cueing was significantly faster than valid cueing, F (3, 33) = 50.293, p<.0001. Interaction between stimuli type and ISI was significant, F (15, 165) = 2.326, p<.005. In addition, the interaction between stimuli type and cue validity was significant, F (3, 33) = 3.161, p =.037. All other effects were not significant.

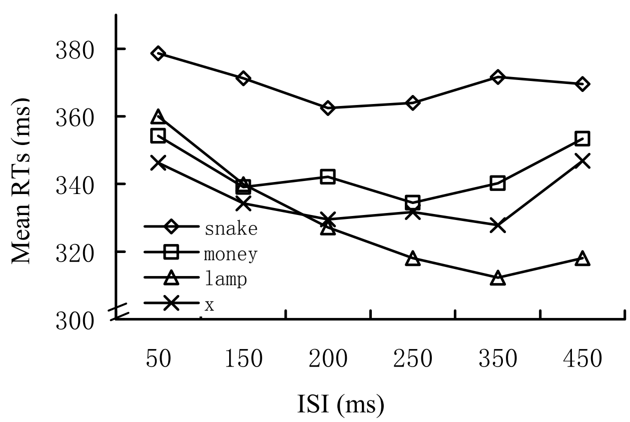

Figure2. Mean RTs for snake, money, lamp and letter "x" across ISI

D. Discussion

As can be seen in Figure 2, participants took longer time to process negative pictures (snake) than to process any other types of stimuli. However, from an evolutionary perspective, snake, as signal of threat, should be processed quickly, but it is not the case in our results.

Now considering the effect of IOR, we could see that in all ISIs RTs of invalid cueing were faster than RTs of valid cueing (the main effect of cue validity was significant and the interaction between ISI and cue validity was not significant), and RTs for different stimuli were depended on cue validity (interaction of stimuli type x cue validity was significant). Planned comparisons were done to better understand the interaction between stimuli type and cue validity. RTs of all type of stimuli except "x" for the invalid cueing were faster than RTs for the valid cueing. According these results we can draw the conclusion that, to some degree, different emotional valences can influence distinctly the allocation of attention.

III. EXPERIMENTS 2

In experiment 1, the consequences that different emotional valences influenced distinctly the allocation of attention may result from the complexity of target stimuli, that is, the low-level perceptual features may play an important role. Thus, we used schematic faces as target stimuli in experiment 2A to eliminate the possible effects of stimuli complexity. Considering the specificity of faces, in experiment 2B the target stimuli were pictures of posture conveying emotional information of happiness, anger and neutral emotion.

A. Method

1) Participants.

Another twenty-four university students participated the experiments and received RMB 10 Yuan as payment. All the participants reported normal or corrected-to-normal vision. Subjects were naive to the purpose of the experiment.

2) Procedure and design.

The procedure was the same as that in Experiment 1, apart from the following changes. The duration of cue was changed to 50ms. In experiment 2A, the targets were three schematic faces, which were the same as those used by Frances A.

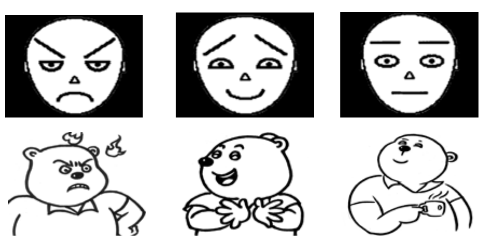

Figure 3. Illustration of schematic faces and postures displaying angry, happy and neutral expressions. Stimuli at upper panel were used in experiment 2A and stimuli at lower panel used in experiment 2B.

employed by Maratos et al. (see Figure 3 upper panel) [9]. In experiment 2B, the targets were three pictures of postures selected from the Chinese Version of Abbreviated PAD Emotion Scales(see Figure 3 lower panel) [10]. Experiment 2A and 2B had a 3(stimuli) x 6(ISI) x 2(cue validity) within-subjects design and each of faces or postures was presented within a block.

B. Results

We can see in Figure 4 that it took longer time to process the negative emotional pictures. In experiment 2A, Mean RTs for angry schematic face were longer than RTs for the other two faces, *F* (2, 22) = 27.674, $p < .001$. The same is true in experiment 2B, *F* (2, 22) = 12.421, $p < .005$. A significant

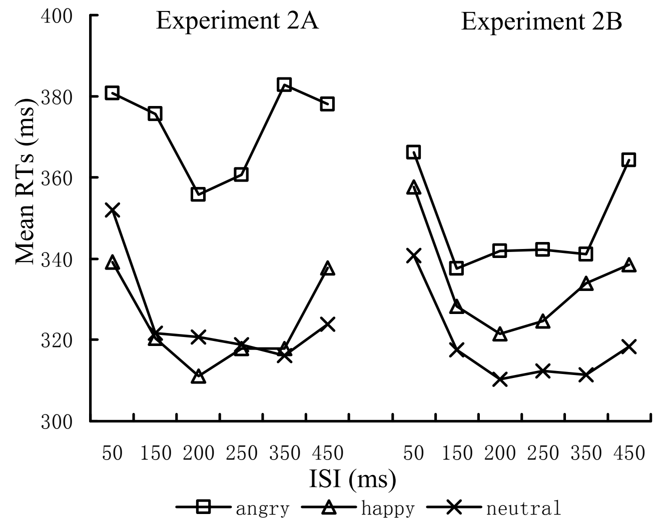

Figure 4. Mean RTs for shematic faces (experiment 2A) and postures (experiment 2B) with angry, happy, and neutral expressions across ISI.

interaction between ISI and cue validity was only founded in experiment 2A, F (5, 55) =2.543, *p*= .039. While conducting a further analysis of the interaction, we found when processing angry pictures there was a facilitatory effect of cueing at the shortest ISI, and there was IOR at each of the other ISIs. In contrast to the processing angry schematic faces, there was a cueing facilitation before 200ms and IOR after 200ms while processing the neutral schematic faces, which was similar to previous IOR research using nonpicture stimuli[11]. There was a significant main effect of ISI in both experiment 2A and 2B, *F* (5, 55) =11.778, $p < .006$, and *F* (5, 55) = 12.643, $p < .005$, respectively. All other effects were not significant.

C. Discussion

When excluding the complexity of stimuli, we found the pattern of results is the same as that in experiment 1. It suggested that different emotional valences have distinct effects on attention. It also showed that emotions not always enhanced early vision, which is consistent with the finding of Bocanegra, B. R. et al.[12]

Emotion could be expressed by face and posture; face expressions had been studied by much research[13], but the posture expressions of emotions were under-investigated. Our data showed that posture emotional expressions were as effective as face expressions on shift of attention.

IV. EXPERIMENTS 3

In previous experiments, we found consistently that negative emotional pictures needed more time to be processed. However if we thought about the procedure of spatial cueing paradigm (IOR), the results we observed seemed to be a bit weird. In spatial cueing paradigm, firstly, attention was captured by the abruptly onset of the cue, then attention disengaged from the cue location and oriented to other place especially to the opposite side of the cue. Now these procedures related to what the types of stimuli were! The expectancy must play a role, or else the shift of attention couldn't depend on what stimuli were. To test this idea, we randomly mixed the target stimuli in one block of trials so that the participants didn't know which stimuli was the target. By this manipulation we could eliminate the effects of expectancy.

A. Method

1) Participants.

Another ten university students participated the experiments who received RMB 10 Yuan for payment. All the participants reported normal or corrected-to-normal vision. Subjects were naive to the purpose of the experiment.

2) Procedure and design.

The procedure was the same as that in Experiment 2, except the changes that all the target stimuli (the three schematic faces used in experiment 2A) were randomly presented in one block of trials. In addition, there was a 0ms ISI. Experiment 3 had a 3 (stimuli) x 7 (ISI) x 2 (cue validity) within-subjects design.

B. Results

When all three schematic faces were randomly presented, the main effect of target stimuli was not significant any more, F (2, 18) =0.398, p = .677. There was a significant interaction between ISI and cue validity, F (6, 54) =5.795, p < .01. The main effect of ISI was significant, F (6, 54) =10.606, p < .01.

C. Discussion

The results were exactly like what we expected. The data suggested that participants' expectancy play a role in attentional shift when exogenous cueing was employed. These results were consistent with previous studies showing that whether negative emotion improves or impairs early vision[12] might be modulated by participants' expectancy.

V. GENERAL DISCUSSION

In all three experiments the data showed that there was a U-function relationship between RTs and ISI (see Figure 5). It will be clarified in the future why these had happened.

According to the data obtained in experiment 1 and 2 that RTs of processing of negative emotional pictures were always longer than RTs of processing other pictures, we can find there might be an avoid response to negative emotional pictures. The cause of these results might exist in participants' expectancy. When a participant knows what stimuli are (when the same target is always present on every trial), and if the stimulus was

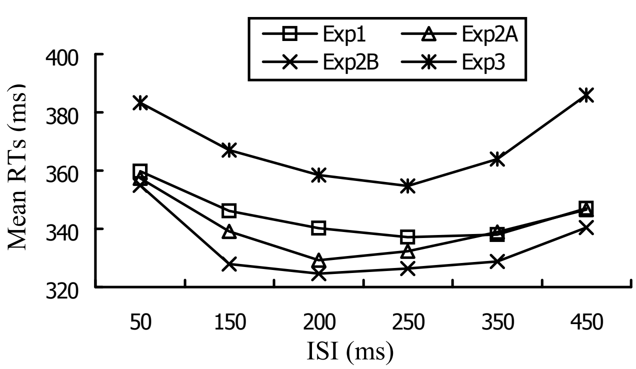

Figure 5.Time course of RTs in three experiments.

negative, there was a avoid response, which resulted in RTs of processing negative emotional picture longer than RTs of processing other pictures. These results tell us that in our experiments the participants used their top-down control of attention. However, the paradigm employed by the experiments was traditionally considered as purely exogenous (bottom-up) control of attention[4]. This should be clarified in the future.

There are many explanations about the mechanism of IOR, such as inhibition account (the most influential one)[3, 14], attentional momentum[15], repetition blindness[7], and other theories[16]. Among these theories, the attentional momentum and inhibition account were investigated extensively[6, 17]. If we assume that attention is inhibited from previously attended location, then we should observe that the RTs should depend on stimuli location but not on stimuli type. But this is not the case in the present study.

The attentional momentum theory[15] proposed that after initial covert orienting to a cued position, attention then is shifted to the location directly opposite the cue, which results in an RT delay at the originally cued location - the IOR effect. The simple attention-shifting account like inhibitory account obtained much for and against evidence[17]. Meanwhile, the attentional momentum theory predicted that there is an opposite facilitation effect (OFE) which referred to those responses to targets opposite the cued position may be relatively speeded. Put another way, the RTs of uncued location should be significantly faster than cued location in our experimental paradigm. Our data did not support this hypothesis. In our three experiments, the main effect of cue validity was only significant in experiment1. There were no significant main effects of cue validity in experiment 2A, 2B and experiment 3 (F (1, 11) =1.893, p = .196, F (1, 11) =1.791, p = .208, and F (1, 9) =0.713, p = .420, respectively).

Given the inconsistency mentioned above, we thought that the theory of repetition blindness (or type-token model, cf. Fox, E. & J.W. de Fockert.[7]) could be a prospective approach to explain the repetition disadvantage (IOR), which proposed that attention might less likely , or had a disadvantage, to select repeated items (objects, attributes, or locations). Our results were more consistent with this hypothesis.

In a word, these results showed that positive (happy) and neutral emotions could be processed more rapidly than the negative emotion (anger), indicating that different emotional valences had distinct influences on attention. It also indicated that the differentiation of emotional valences on attention could be explained by participants' expectancy.

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