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The Influence of Stimuli Valence, Task Difficulty, Neuroticism and Emotion Regulation on Visual Search Within Real-world Scenes

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Abstract: Affective traits are essential in clinical psychology, including neuroticism and emotion regulation (cognitive reappraisal, expressive suppression). Both neuroticism and emotion regulation has been associated with the development of affective disorders, and emotion regulation therapies have been used in clinical treatment. Therefore, the current study of neuroticism and emotion regulation may provide a more effective intervention for people who suffer from affective disorders. In previous studies, real-world emotional scenarios have been demonstrated to affect visual search tasks. But whether affective traits will influence neutral target search in the real emotional world is still unknown. Although task difficulty, i.e., cognitive load, can affect visual search, it hasn't been investigated as an independent variable. A neutral target visual search paradigm will be used in the present experiment. The experiment will be divided into manageable and challenging tasks in which participants will be asked to identify neutral targets embedded in moving images. Findings from the present experiment increase our understanding of neuroticism, cognitive reappraisal, expressive suppression, and task difficulty in our ability to distribute attention while viewing real-world scenes during the visual search task.

Keywords: neuroticism, cognitive reappraisal, expressive suppression

1. Introduction

Selective visual attention is the bias in attention resources brought about by the incapacity to simultaneously pay attention to all objects and regions of the visual world. Both bottom-up and top-down processing contribute to the bias of such resources. Emotional cues may influence selective attention, known as emotional attention, in addition to the standard bottom-up and top-down processing [1].

The current research was to determine if differences in the stimulus value and the effect of task difficulty on attention allocation resulted from the use of neurotic and habitual emotion regulation techniques.

The experiment has five independent variables: stimulus value, task difficulty, cognitive reappraisal, expressive suppression, and neuroticism. The hypotheses regarding this experiment are the following respectively. Firstly, the accuracy of visual search tasks in positive trials will be reduced. The response time of the visual search task in negative trials will be prolonged. Secondly,

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individuals with high levels of neuroticism have longer reaction times and lower accuracy rates for visual search tasks in natural scenes. Third, individuals with high levels of cognitive reappraisal have higher accuracy rates in real-world scenes on visual search. Fourthly, Individuals with high levels of expressive suppression have shorter response times and higher accuracy rates for visual search in natural scenes. Finally, regarding task difficulty, when the task is difficult, the response time of the visual search in natural scenes is longer, and the accuracy rate is lower. Neuroticism, expressive suppression, and cognitive reappraisal will show interactions with stimulus valence when the task is complex.

2. Literature Review

Bendall's paper investigated how emotional real-world scenes affected participants' attention during visual search tasks. This experiment investigated whether the stimuli valence affects the visual search using a visual search paradigm with a neutral target [2]. In Nencki's emotional picture system, these targets were embedded in images of various emotional valences (positive, neutral, negative) [3]. The pictures were all real-world scenes. It was discovered that search targets embedded in negative and positive stimuli were slower and less accurate to recognize than targets embedded in neutral stimuli [2]. So the conclusion is those real-world emotional stimuli can affect visual search tasks.

There are two other limitations to this experiment. First, the sample was exclusively female, and the study's results may not be generalizable to men [2]. Furthermore, the arousal levels of the images are not controlled. Negative stimuli are generally high arousal, while positive stimuli are generally low arousal [4]. Therefore, our results may be due to the effects of stimulus arousal rather than differences in the stimuli valence.

Neuroticism and extraversion in a change detection task were found to be predictors of attention performance by Hanh's experiments [5]. Both neuroticism and extraversion belong to the Big Five personality qualities. Based on their ability to control their emotions and self-regulation, persons are assigned a position on a continuum by the neuroticism dimension. Those with high Neuroticism scores frequently felt depressed and had extreme mood swings. Low neuroticism individuals were more composed, well-adjusted, and less prone to solid emotional eruptions. The extraversion dimension has extreme extraversion on one end and severe introversion on the other. Extroverts are gregarious, enthusiastic, upbeat, amiable, and decisive. Contrarily, introverts are quiet rather than aggressive, independent rather than dependent, and stable rather than sluggish.

In Hahn's study, increased levels of extraversion predict increased accuracy in change detection tasks. Increased neuroticism also predicts a decline in change detection task accuracy. According to research, extraversion predicts improved attention performance, while neuroticism is linked to decreased visual attention control. Although more excellent attention performance can be predicted by extraversion, this impact is less significant than the relationship between attention and neuroticism [5].

The study aimed to draw attention to the connection between neuroticism and poor attention control, not to support emotion-related attention regulation [5]. This study did have one drawback. The experiment's images' emotional neutrality was not guaranteed, and the outdoor scenes in the images might have positive emotional value.

Bendall's paper investigated how stimuli valence, extraversion, and emotional regulation affect visual search in natural scenes. Several emotional problems, like depression, are correlated with emotional regulation. In this experiment, expressive suppression and cognitive reappraisal were the emotion regulation techniques investigated. Cognitive reappraisal allows people to reevaluate possible emotional value by altering the emotional impact. Expressive suppression is the act of suppressing ongoing emotional expression [6].

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Emotional Regulation Questionnaires (ERQ) will be used to examine the habitual use of the Emotional Regulation strategy. The levels of extraversion will be assessed using the Neo Five-Factor Inventory-3 (NEO-FFI-3). The procedure for the experiment was the same as that of the previous study by Bendall et al., except that two questionnaires had to be completed. Also, it was discovered that search targets embedded in negative and positive stimuli were slower and less accurate to recognize than targets embedded in neutral stimuli. More significantly, those with higher degrees of expressive suppression were quicker to recognize targets regardless of the stimuli' valence [6].

In the experiment, extraversion did not impact attention. Cognitive reappraisal and expressive suppression also didn't influence the accuracy of identifying the target in visual search tasks. Moreover, the visual search performance was not impacted by the interaction of extraversion, expressive suppression, and cognitive reappraisal with the stimuli valence [6]. These results are contrary to previous studies. This may be due to the different tasks used by researchers. The visual search task used in this study did not have enough task difficulty in mobilizing sufficient resources. The insufficient task difficulty is insufficient in cognitive load.

According to the notion of cognitive load, there are three fundamental contributions to the overall cognitive burden. External cognitive load is brought on by the instructional material used to deliver the content. In contrast, the inherent qualities of the content that needs to be learned are related to intrinsic cognitive load. Finally, closely related cognitive load is the load imposed by the learning process [7]. The difficulty of the subject is correlated with the intrinsic cognitive load. Materials with more interactive aspects are thought to be more challenging than those with fewer interactive elements or minimal interaction. The quantity and interaction of domain elements affect intrinsic load, which is also influenced by other elements.

The following experiment will refine the previous ones. Unlike Bendall's experiments, there will be equal numbers of men and women among the participants in the following experiment [2]. So the study results can be generalizable to both men and women.

Because the emotional valence of the stimuli was not controlled for in the Hahn et al. experiment, this may have implications for the study [5]. The following study was designed to examine how affective traits and attention relate to the emotional valence of the stimulus. The following experiment will continue to investigate the relationship between personality and other behavioural tendencies, from studying change detection tasks to studying visual search tasks to understand further the factors that predict individual differences in attention performance.

Extraversion did not affect attention in the study by Bendall. Additionally, it did not impact a visual search task's accuracy or reaction time [6]. The variable extraversion will be replaced with neuroticism which, like extraversion, is also an emotional trait and one of the Big Five personalities. Therefore, this experiment will investigate the neuroticism that had a stronger connection to attention in the change detection task [5]. So the present experiment intends to study neuroticism as a new variable.

In the Bendall's experiment, results appeared opposite to previous studies, which could be due to the task's difficulty [6]. So task difficulty will also be introduced as a new independent variable in the experiment. The increase in task difficulty increases cognitive load [7]. So increasing the task's difficulty increases the competition for cognitive resources and mobilizes enough cognitive resources to reveal previously undetected effects. The experiment will have an easy task and a difficult task. The easy task is the same as the task in Bendall et al. The challenging task will increase the task's difficulty on top of that [6]. This experiment increased the task's difficulty by increasing the number of elements, thus increasing the cognitive load of the subjects.

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3. Method

3.1. Participants

There will be 50 Chinese university students aged 18 to 24, of whom 25 are female, and 25 are male. Participants need to provide informed consent. Ethics-related guidelines and regulations conduct all methods to protect the rights of the participants.

3.2. Design

There will be five independent variables employed in a mixed design. The within-subjects factors are task difficulty (easy task, difficult task) and the emotional valence of the stimuli (negative, neutral, and positive). Between-subjects factors are neuroticism, expressive suppression, and cognitive reappraisal. The dependent variables are behavioural performance, i.e., accuracy in identifying the search target (correctness) and reaction time (seconds) to assess.

3.3. Materials

Psychopy will be used to experiment, and they need to provide informed consent. Participants will complete the study using a monitor. Real-scene images from the Nencki Emotional Picture System will be chosen based on emotional value ratings [3]. For the search task, 192 photos—64 positive, 64 neutral, and 64 negative—will be used. All images are coloured and fixed in size. For the simple visual task, the letter T or L is a target, and they will be embedded in the selected images with the same font size [6]. For the difficult task, the letter T or L is the target, and the letter F, J, H, I are interferences. There will be only one T or L letter and two F, J, H, I letters. All letters will be embedded in the selected images with the same font size. The real-scene images regarding luminance, contrast and entropy will be evaluated.

The Emotion Regulation Questionnaire (ERQ) will examine the frequency with which emotion regulation strategies are used. This 10-item self-report questionnaire scores two strategies to regulate emotions: expressive suppression and cognitive reappraisal, which asks how people control their emotions. On a scale from 1 to 7, all items are reported. The six questions are used to test cognitive reappraisal. Six questions are used to assess cognitive reappraisal. Four questions are used to assess cognitive reappraisal. The levels of neuroticism will be assessed using the Neo Five-Factor Inventory-4 (NEO-FFI-4). A 5-point Likert scale from 0 to 4 rates the personality traits and characteristics covered by the scale's 60 items. Twelve questions are used to evaluate each trait.

3.4. Procedure

Participants will fill out the ERQ and NEO-FFI-4 questionnaires after they have once more given their informed consent. The task's instructions will be given to participants. Participants will be instructed to push the space bar when they are prepared to start. The article by Bendall et al. served as the basis for the visual search task [6]. Participants will perform the simple visual search task first. A fixation cross will be presented for 1000 milliseconds to start the trial. There will be a presentation of positive, negative or neutral real-scene images with a T or L superimposed. The image will be held until the participants press the T or L letter with the mouse. Feedback will be provided. Participants then will perform a difficult visual search task. The trial will also begin with the same fixation. There will be a presentation of a negative、 positive or neutral image with the Letters T, L, F, J, H, I superimposed on it. Letters T and L are the target. The image will be held until the participants press the T or L letter with the mouse. Feedback will be provided before

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starting the following experiment. Participants finished 192 randomly given questions in total. The information gathered will include accuracy and response time.

4. Predictable Result

Over two standard deviations from the mean, outliers are removed. The effects of stimulus value, task difficulty, expressive suppression, cognitive reappraisal, and neuroticism on visual search will be examined using linear mixed-effects models. The predictions are based on and adapted from the article by Bendall [6].

The main effect of stimuli valence on accuracy will be significant. According to a planned comparison, targets embedded in neutral scenes will be more accurate than those embedded in festive scenes, with no difference between neutral and negative scenes. According to additional post hoc analyses, targets embedded in negative scenes will be more accurately identified than targets embedded in festive scenes. The main effects for neuroticism will be significant; the main effects for cognitive reappraisal will be significant; the main effects for expressive suppression will be significant; and the affective traits will interact with the stimuli valence.

The main effect of stimuli valence on response time will be significant. According to a planned comparison, targets embedded in neutral scenes will be identified more quickly than those embedded in negative scenes, with no difference between neutral and positive scenes. According to additional post hoc analyses， targets embedded in festive scenes will be identified more quickly than targets embedded in joyous scenes. The main effects for neuroticism will be significant; the main effects for cognitive reappraisal will be significant; the main effects for expressive suppression will be significant; and affective traits will interact with the stimuli valence [6].

5. Future Implication

According to research, emotions have diverse effects on attention that are influenced by various things, including the emotion's inherent characteristics. The current experiment used a visual search task to examine the impact of emotion with stimuli in real-world scenes and discovered that emotion stimuli divert attention during visual search, supporting prior research in similar fields.

Our results indicate that people who used expression suppression more frequently had quicker reaction times, indicating that this ER strategy could improve cognitive performance, particularly visual attention. Several studies confirm this claim, which revealed that effective ER is linked to enhanced behavioural performance and brain activation while completing the Stroop test [8]. These investigations, when taken along with the findings presented here, imply that expression suppression is linked to enhanced executive skills (such as reaction inhibition, cognitive control, and visual search). Visual working memory capacity is a potential mechanism that connects ER to better visual search performance; nevertheless, more study is needed in this area. Recent research has supported this claim by demonstrating that working memory training can increase ER capacity [9].

On the visual search task, habitual cognitive reappraisal didn't affect the response time or accuracy. An advantage of the current study is that it measures frequent usage of ER strategies than giving participants instructions on how to employ specific ER techniques to complete tasks [10]. A similar strategy might advance our knowledge of the neurological processes supporting ER.

Clinical research may be affected by recent findings that repetitive application of expressive suppression strategy reduces the capacity to accurately recognize neutral targets in natural scenes. The neurobehavioral treatment of mood disorders has successfully used attention-training techniques. Moreover, patients with anxiety and sadness have improved clinically after ER therapy

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[11]. Individuals with emotional disorders may benefit more from therapy that also targets adjustments in attention allocation and fosters habituation to successful ER strategies.

Despite some of its benefits, there are still certain disadvantages to the current experimental design. When valence was used to choose the stimuli, they varied in their arousal levels, even though they were strictly matched at the brightness, contrast, and entropy levels in the current study. As a result, it is still feasible that arousal levels, rather than changes in valence, are what causes the effects of stimulus potency on visual search observed in the experiment [4]. Yet, other studies examining valence and arousal effects contend that valence is the main factor affecting visual attention [12]. More research is required to understand the independent effects of arousal levels and stimuli valence in natural scenes on visual search.

6. Conclusion

In conclusion, this experiment will investigate the effect of four variables. The first is the effect of the value of emotional stimuli. The accuracy of visual search tasks will be reduced in positive trials. The response time of the visual search will be prolonged in negative trials. This was confirmed in the experiments by Bendall.

The second is the effect of emotion regulation strategies. Individuals with high levels of expressive suppression have shorter response times and higher accuracy rates for visual search tasks in natural scenes. This was also confirmed in the experiments by Bendall et al. However, Individuals with high levels of cognitive reappraisal may not have higher accuracy rates for visual search in natural scenes because cognitive reappraisal did not affect the visual search in natural scenes in previous studies. This was thought to result from the low cognitive load, and the current experiment increased the cognitive load of the visual search task. However, it is also possible that this was not caused by cognitive load, and it is also possible that the cognitive load in the current experiment was not sufficient.

The third one is the effect of neuroticism on real-world visual search. Individuals with high levels of neuroticism have longer reaction times and lower accuracy rates for visual search tasks in natural scenes. Levels of neuroticism can influence attention performance on change detection tasks, according to earlier research. However, this experiment uses a visual search task different from the predicted change detection task. So it is also possible that neuroticism does not affect the visual search task for real-world scenes.

The fourth one is the effect of cognitive load in natural scenes on visual search. When the task is difficult, the response time of the visual search in natural scenes is longer, and the accuracy rate is lower. This also lacks some experimental support.

Finally, when the task is difficult, Neuroticism, expressive suppression, and cognitive reappraisal will show interactions with stimulus valence. Although in previous Bendall's experiments, extroversion, expressive suppression, and cognitive reappraisal did not interact with the stimuli's value. This interaction may be confirmed after the current experiment with increased cognitive load.

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