ERP Studies on Attention Bias of Optimistic Individuals towards Social Information

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ABSTRACT
This paper attempts to clarify the impact of optimism on the distribution of attention, the attention to emotional words among optimistic students, and the exact relationship between optimism level and subliminal attention distribution. For these purposes, the author explored the subliminal attention of optimistic college students towards emotional words with the aid of the dot-probe task (DPT). The method, materials and procedure of the DPT experiment were introduced in great details, and the data on recipients’ behaviours and event-related potentials (ERPs) were analysed one by one. Through the analysis, it is concluded that individuals with different optimism levels differed in their attention distribution facing the same social information. In terms of behaviours, high-optimism recipients responded faster to positive social information than low-optimism recipients; In terms of ERPs, the high-optimism group had a much lower latency and greater effect than the low-optimism group in terms of visual N1 and linear predictive coding (LPC). The above results jointly suggest that individuals with high-optimism are more alert to positive social information than those with low-optimism. The research findings lay a solid basis for similar studies on attention bias and ERPs.

Key Words: Optimism, Attention Bias, Event-Related Potential (ERP), Social Information, Dot-Probe Task (DPT)

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Introduction
Many studies show that optimism enables individual to stay away from depression and avoid the negative health impacts of bad emotions (Rauch et al., 2002). It is positively correlated with life satisfaction, and negatively with depression. As a result, optimists are more immune to depression and satisfied with life than pessimists, and enjoy a higher subjective happiness index than the latter. In essence, optimists and pessimists have different emotional mechanisms (Snyder and Shane, 2002). The cognitive process of optimists is shaped by more positive moods than that of pessimists. The difference in emotional mechanism can be explained by attention bias, i.e. the vigilance-avoidance of stimuli. Over the years, much research has been done on attention bias of different individuals. For example, Sohl et al., (2011) executed a modified version of dot-probe task (DPT) in a non-pressure environment, revealing that individuals with a highly anxious experience react more rapidly than those without such an experience to the dot presented in the location of negative words. The components of attention bias were evaluated by the reaction time measured under the active clue, where the dot appears on the side of the threatening stimulus, and the inactive clue, where the dot appears on the opposite side. Quicker reaction time to the dot under the active clue was interpreted as vigilance to threat, while faster

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reaction time to the dot under the inactive clue was interpreted as the opposite side. Quicker reaction time to the dot under the active clue was interpreted as vigilance to threat, while faster reaction time to the dot under the inactive clue was interpreted as avoidance of threat (Teicher et al., 2003). Similarly, the DPT has been extensively employed to explore the distribution of attention bias towards emotional words among those with anxiety and depression, especially college students. Both supraliminal stimulus (500ms) and subliminal stimulus (14ms) have been investigated in relevant studies (Simmons et al., 2008; Stam, 2007).

Despite the preliminary results on the effect of optimism on the shift of attention, the previous studies fail to clarify the impact of optimism on the distribution of attention, or the attention to emotional words among optimistic students, not to mention the exact relationship between optimism level and subliminal attention distribution. To solve the problem, this paper explores the subliminal attention of optimistic college students towards emotional words with the aid of the DPT. It is assumed that the students at a high level of optimism needs a much shorter reaction time than those at a low level under both active and inactive clues (Tural et al., 2004; Urberg et al., 2005).

**Methods**

**Recipients**

A total of 570 undergraduates were selected by stratified cluster sampling from Central China Normal University (CCNU). All of them participated in our questionnaire survey on optimism. In the end, 537 valid questionnaires were returned from the recipients. Then, the recipients were ranked in descending order of the total score on their questionnaires. 15 students were randomly chosen from the top 27% to form the high-optimism group, and another 15 from the other students to form the low-optimism group. Each group contains 7 males and 8 females, aged between 18 and 22 (SD=0.89). All recipients are righthanded with normal or corrected visual acuity. Each of them gave informed consent before the experiment, and received a reward after the experiment.

**Materials**

The materials consist of 120 15cm×15cm white-background, blue-edge images, each of which has 425×425 pixels. All images were processed by a universal standard in Photoshop 7.0. These images are about the social situation. Half of them are positive and the other half are negative. The images were processed in the following manner. First, four master students of psychology were invited to divide 200 social situation images into positive ones and negative ones, and give a rating to each of them. Among them, 165 images of highly consistent rating were selected and rated again by 60 students (56 male and 34 female) against a five-point scale and the emotional valence (1: positive; 2: neutral; 3: negative). In this way, 70 images of uniform properties were identified as the experimental materials. These images were further split into two categories: positive social images and negative social images. Then, the ratings given by the 60 students were subject to variance analysis. The results demonstrate a major difference between the two image categories. The conclusion agrees well with the result of repeated measures analysis of variance (ANOVA) (p<0.05). To sum up, there are two clues (active/inactive), two image categories (positive/negative), two groups of recipients (high/low-optimism), and thus two types of stimuli (35 each for positive and negative images) in the experiment. The different kinds of dyes, images (stimuli) and recipients were combined in different ways during the experiment.

**Procedure**

During the experiment, the recipients sat on soundproof and electromagnetic shielding seats 80cm away from a 17” monitor, and stared at the centre of the monitor at a visual angle of about 4.8×4.8. The monitor has a white background, and uniform brightness, contrast and colour. The experimental materials were mapped by E-Prime. Then, stimuli were randomly presented in the centre of the monitor as word pairs, while the recipients were asked to control the blink at the appearance of the stimuli. The word pairs appeared at the subliminal level of visual perception (30ms). Each pair, consisting of a negative word and a positive word, was followed by a pair of masking stimuli (any combination of letter strings), also appearing at 30ms.

When the dot appeared in one of the locations of the masking stimuli, the recipients should press a key as soon as possible. If the dot was on the left side, the key “1” should be pressed; if the dot was on the right side, the key “2” should be pressed. For both negative and positive words, the chances of appearing on the left side and the
right side were both 35%. At the end of the experiment, the results were displayed to show how each participant reacted to the stimuli. Before the formal experiment, the participants practiced the task repeatedly to get familiar with the experimental procedure.

The left and right hand keys are balanced between participants. As shown in Figure, the active clue means the dot appears on the side of the negative word, while the inactive clue means the dot appears on the opposite side. The experiment was carried out in two sessions, each of which contains 140 trials. In each trial, the recording lasted for about 20min. A 2min break was reserved for all recipients after each session.

**Acquisition of event-related potentials (ERPs)**

The ERP recording and analysis system (Neros, US) was adopted to record the ERPs. The sampling rate as 500Hz and the bandwidth is DC 0.05~100Hz. During the experiment, the 64-pole cap was applied following the International 10~20 system. Taking the bimastoid line as the reference electrode, the forehead of the recipient was grounded. Then, the horizontal electrooculograms (HEOGs) were recorded on the outside of both eyes and the vertical electrooculograms (VEOGs) above and below the left eye. The behavioural data were captured during ERP acquisition. Then, the captured data were processed offline. The VEOGs and HEOGs were automatically corrected with artefacts fully removed. For the purpose of this experiment, the offline processing was focused on the ERPs induced by the appearance of the images. The ERP records were treated by superimposing and averaging. The data on artefacts, such as blinking, eye movements and myoelectricity were excluded at ±50μV. The ERP records with the correct reaction were superimposed over 60 times. For those recipients whose amplitude was greater than -t80V, the artefacts were considered as automatically removed. The window of analysis starts from 400ms after the appearance of the images, while the baseline was set to 50ms before the appearance of the stimuli. The data were analysed by SPSS 17.0, and the P value of the variance analysis was corrected by the Greenhouse-Geisser:

**Results**

**Behavioural data**

The repeated measures ANOVA was performed on the reaction time and reaction accuracy captured in the experiment on the two clues and two groups of recipients. The results show no significant impact on the reaction time or reaction accuracy (P>0.05). Under active and inactive clues, the two groups of recipients differed greatly in the reaction time, indicating that the high-optimism group (F(1,25)=4.679, P=0.039) reacts to stimuli must faster than the low-optimism group (F(1,25)=4.734, P=0.037).

**Table 1. Judgement accuracy and response time of two groups of participants in all types (M±SD)**

<table>
<thead>
<tr>
<th></th>
<th>High optimism level group</th>
<th>Low optimism level group</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Accuracy</td>
<td>Time reaction</td>
</tr>
<tr>
<td>Active clues</td>
<td>99±.006</td>
<td>337.41±1.33</td>
</tr>
<tr>
<td>Inactive clues</td>
<td>99±.006</td>
<td>345.84±10.09</td>
</tr>
</tbody>
</table>

**ERP data**

For dot analysis, the appearance of stimuli was taken as point zero of superposition. Thus, the window of analysis was set to -50~400ms, and the baseline was set to -50~0ms. The baseline amplitude and latency of visual N1 (100-200ms) and linear predictive coding (LPC) (300-400ms) were measured, and subject to repeated measures ANOVA considering different clues, groups, stimuli and electrodes (see the measurement position of each component). In light of the experimental conditions, the ERP data were superposed and averaged to yield the average amplitude of each condition, that is, active clue and inactive clue. As shown in the overall average figure, both conditions induced visual N1 and LPC components.

(1) Comparison of Visual N1

This section analyses the variance of visual N1 latency and amplitude recorded in the experiment on two clues, two groups of recipients and eight electrodes (F1, F2, F3, F4, Fz, FCz, FC5 and AF4).

Through the visual N1 latency analysis, there was a significant interaction as F(1, 25)=6.799, P=0.019. Further comparison shows that the high-optimism group had a much lower latency than the low-optimism group (F(1,25)=6.527, P=0.024). The visual N1 amplitude analysis reveals a prominent interaction as F(1,25)=11.734, P=0.004. Further analysis clarifies that the high-optimism group had a much greater effect than the low-optimism group (F(1,25)=14.327, P=0.002).
This section investigates the variance of LPC latency and amplitude recorded in the experiment on two clues, two groups of recipients and eight electrodes (F1, F2, F3, F4, Fz, FCz, FC5 and AF4).

Through the LPC latency analysis, there was a significant interaction as $F(1,25)=9.501$, $P=0.029$. Under the active clue, the latency of high-optimism group was significantly lower than that of low-optimism group ($F(1,25)=17.774$, $P<0.001$). The LPC amplitude analysis reveals a prominent interaction between the type of clue and the group of recipients ($F(1,25)=5.743$, $P=0.032$). Under the active clue, the high-optimism group had a much greater effect than the low-optimism group ($F(1,25)=7.013$, $P=0.013$). In contrast, there was no major difference between the two groups in latency or amplitude of LPC ($P>0.05$) under the inactive clue.

**Conclusions**

**Behavioural results**

The experimental data on behaviours show a significant interaction during the reaction, and the faster response of the high-optimism group to social information (including positive and negative words). The results are consistent with the previous studies. For instance, children's interpretation of inducement, including self-evaluations, can affect subsequent behaviour (Crick and Dodge, 1994). In other words, the coding, interpretation and reaction of social information depend on the cognitive disposition of children. Most of the existing research agrees that optimism is a cognitive disposition featured by the positive perception and fast response to social information.

A possible reason for the results lies in the optimistic cognition mechanism of social information. Optimism, as an inherent personality, is externalized as a positive cognition mechanism, including positive expectations for the future and positive acceptance of the past. By this mechanism, high-optimism individuals both eagerly expect positive social information, and reasonably explain negative social information. In this way, this kind of people tends to response fast to all kinds of social information.

**ERP results**

The ERP results reveal that the visual N1 latency of high-optimism group was much lower than that of low-optimism group, while the effect of high-optimism group was far greater than that of low-optimism group. The visual N1, an early and exogenous ERP component, is influenced by the physical properties of stimuli. Some scholars held that the N1 complex recorded from the frontal, apex posterior and occipital responds to voluntary spatial attention, and actively regulates the initial phase of visual processing (Vera et al., 2008). The edge of optimistic individuals may be attributed to the fact that they perceive social information at a low cognitive threshold, and...
make early response based on the optimistic brainwave.

Through the analysis of LPC latency, it is learned that high-optimism group had a far lower latency than low-optimism group under active clue. The LPC amplitude analysis shows the lead of the high-optimism group in terms of the effect. To some extent, the LPC reflects the information update and processing in working memory (Vosgerau, 2010). It is believed to correlate with long-term memory and the recognition process (Finnigan et al., 2002; Van et al., 2009). Many scholars empirically concluded that the LPC, located in the parietal lobe, plays a certain role in late-stage decision-making and response (Van et al., 2009; Walters and Inderbitzen, 1998), as well as detailed cognitive assessment and interpretation of stimuli (Wei et al., 2001). With a shorter latency of LPC, the high-optimism recipients are more sensitive to positive social information under active clue, that is, they are vigilant to positive social information. Moreover, the high LPC amplitude of the optimists comes from their excitement on positive social information, and the activation of large parts of the brain (Wessa et al., 2006). The above results jointly suggest that individuals with high-optimism are more alert to positive social information than those with low-optimism.

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