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Effects of attentional training on visual attention to emotional stimuli in archers: A preliminary investigation

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ABSTRACT

Attentional training has been used to modify attentional bias patterns in anxious individuals. This study examined the effect of attentional training on anxious archers' information processing using electrophysiological indices. Eighteen experienced archers with relatively high levels of competitive anxiety were assigned to either a training group or a control group. The training group received a 6-week attentional training protocol that was designed to switch attention away from threats, whereas the control group participated in a placebo training. The results revealed a smaller P1 difference wave for the training group in the posttest compared with pretest, whereas no change in N1 amplitude was found after training. The P1 difference wave finding suggests that more similar visual attentional resources were invested in probes replacing positive cues compared with probes replacing threatening cues after attentional bias training. In particular, archers who accepted training deployed similar attention resources to threatening and positive stimuli but those who accepted sham training avoided attention from threatening stimuli.

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1. Introduction

Attentional bias is relevant to trait anxiety magnitude and refers to a cognitive preference that frequently drives individuals' attention toward specific types of emotional stimuli in their surroundings (Bar-Haim et al., 2007; MacLeod et al., 1986). Trait anxiety is usually perceived as how people feel across typical situations, whereas state anxiety involves how a person is feeling at the time of a perceived threat and is considered temporary (Spielberger and Sydeman, 1994). Threat-related attentional bias in anxiety has been investigated mainly for trait anxiety because participants in anxiety and control groups are more significantly different in their levels of trait anxiety than state anxiety (Bar-Haim et al., 2007). The causal relationship between trait anxiety and attentional bias toward threats is still debatable. Some propose that habitually paying attention to threats may be a characteristic of highly anxious individuals, while others believe that attentional favor to threats may lead to greater anxiety levels. Still others believe that the relationship between trait anxiety and attentional bias toward threats may be mutual. Although the direction of causality between trait anxiety and attentional bias is not clear at this moment, research supports that an individual's propensity to disproportionately allocate their attentional resources toward potential threats leads these stimuli to be processed frequently and to a greater degree, which then induces higher state anxiety (Williams et al., 1996). Thus, this bias toward threat is considered a critical factor regarding anxiety (Carretié et al., 2004).

Attentional bias theories may be utilized to understand the formation of sport-related trait anxiety. Previous studies indicate that athletes who demonstrate relatively high levels of competitive trait anxiety were more likely to perceive their sport environments as threats (Martens and Gill, 1976). According to the hypothesized reciprocal relationship between attentional bias and anxiety, it is conceivable that athletes who possess high competitive trait anxiety may develop a specific pattern of attentional bias toward sport-related threats, which in turn contributes to the severity of their competitive trait anxiety. Approaches based on rectifying inappropriate attentional tendencies, such as attentional training, can be developed to reduce the high levels of competitive trait anxiety experienced by these athletes.

The effectiveness of attentional training on reducing anxiety in subclinical and clinical populations has been supported by recent studies. It was reported that attentional training significantly decreased anxiety scores (Li et al., 2008), reduced emotional responses during a task relevant to individuals' anxious concerns, and facilitated the abilities of individuals with subclinical levels of anxiety to disengage their attention from threat cues (Amir et al., 2008). For individuals with clinical anxiety, attentional training may reduce anxious symptoms (Hazen et al., 2009). However, athletes represent a special population because they constantly face pressures from training and competition, and may thus have developed specific coping strategies. These coping strategies allow the athlete to regain control of unpleasant situations. In some respects, athletes use avoidance coping which

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entails a "turn away from the threat related cues" (Krohne, 1993, p.21). In light of this, the attentional training applied to clinical or subclinical anxious individuals may be applicable to athletes. However, whether the effectiveness of attentional training is generalizable to the athletic population remains to be tested.

Moreover, attentional training protocols should be refined to reduce confounding effects. The majority of attentional bias training protocols have been designed based on the dot-probe task (e.g., Hazen et al., 2009), which adopts a dual-stimulus paradigm to examine attention allocation by calculating reaction time (RT) (MacLeod et al., 1986). Typically, threatening-neutral emotional stimuli are paired together as a cue to explicitly test how threatening stimuli influence anxious individuals' attentional processing. However, attentional bias may stem from high arousal levels due to the mere presence of emotionally threatening stimuli rather than their threatening characteristics (Bradley et al., 2001). It is suggested that arousal levels be controlled when manipulating the different valences of emotional stimuli to investigate the effects of attentional training (Johnson, 1993). Therefore, the present study aimed to apply a modified attentional bias training protocol, which was used in a recent study (Baert et al., 2010), to modulate the attentional bias patterns of athletes with high competitive anxiety. The paradigm adopted a pairing of threatening-positive words as cues to equalize the arousal levels between these two types of cues that feature negative and positive emotional valences, respectively.

Furthermore, the current study attempted to utilize event-related brain potentials (ERP) in addition to behavioral measures to provide understanding regarding the neural processes underlying effects of attentional training. In visual ERPs, the P1 and N1 components are generated in the extrastriate cortex (e.g., Natale et al., 2006) and are modulated by attention (e.g., Luck et al., 1990; Zanto et al., 2010). Recent studies of healthy participants reported enhanced probe P1 amplitudes after angry compared to happy faces (Santesso et al., 2008) and after fearful compared to happy faces (Pourtois et al., 2004) in a dot probe paradigm, and enhanced P1 amplitudes to emotionally congruently primed targets (fearful faces) in contrast to incongruently primed ones in a spatial cueing paradigm (Brosch et al., 2011). Santesso et al. (2008) interpreted their results as indicative of increased sensory gating for emotionally cued stimuli in the visual cortex and in line with theories on hyper vigilance toward threat. With regards to the N1 component, Fu et al. (2005a,b) revealed that invalid trials eliciting larger N1 at electrode sites contralateral to stimulus side than valid trials. In addition, a decreased N1 component was revealed for emotionally cued probes (Mueller et al., 2009). Decreased N1 may result from either sensory adaptation or overlapping with the late portion of the P1. As such, observation of changes in the amplitudes of these two ERP components may aid in understanding the cortical activities of attentional training. This understanding is critical for designing intervention programs to prevent the occurrence of excessive competitive anxiety in athletes.

Taken together, the present study aimed to extend previous findings from clinical and subclinical populations to the athletic population. Archers were selected for the present study because archery, similar to other aiming sports, is classified as a closed motor skill with heavy demand on the ability to ignore distractions/interferences stemming from the external or internal environment (e. g., Vine and Wilson, 2011). The importance of ignoring threatening stimuli has been confirmed by our interviews with archers prior to the start of this study. These archers indicated that previous negative competitive experiences (e.g., negative feedback from significant others, pressure to win, and score) from training conditions or competitions constantly interfered with their concentration during the competition, and frequently impaired their performance. It was hypothesized that pre-elite archers should allocate less attention toward threats and invest more resource toward positive information after training. Specifically, compared with a control group, the training group should demonstrate slower RTs and smaller amplitudes of the P1 and N2 components when responding to trials in which probes replaced threatening cues. Conversely, this group should exhibit faster RTs and larger amplitudes of the ERP components when responding to trials in which probes replaced positive cues. This study is innovative given the current lack of research focusing on the development of possible interventions to moderate competitive trait anxiety in athletic population using attentional bias training protocols.

2. Method

2.1. Participants

At the beginning of this study, 60 pre-elite college archers in Taiwan were recruited and asked to complete the Sport Competition Anxiety Test (SCAT; Martens, 1977), one of the prominent competitive trait anxiety measures in use by sport psychology researchers, to screen for individuals with high competitive anxiety. The SCAT scores ranged from 10 to 30, with a higher score indicating a higher level of anxiety. Originally, 22 participants who scored in the higher one-third on the SCAT were selected as our participants. Three of them couldn't follow our experimental schedule, and one dropped out due to a car accident. As a result, there were 18 target participants (SCAT: 21.61 ± 2.30). A t-test showed that the SCAT score was significantly higher for the 18 participants than those who were not selected ($t(55) = 2.83$, $p < .01$). These archers were randomly assigned to either the training group (6 M, 4 F; age = 19.80 ± 1.40 years, sport age = 6.55 ± 1.38 years) or the control group (4 M, 4 F; age = 20.25 ± 1.04 years, sport age = 6.37 ± 1.19 years). All participants were healthy, had self-reported normal or corrected-to-normal eyesight, and had about 5 years of competitive experience at national and international levels with average scores of over 300 with 36 arrows (70 m). All participants were provided with a written consent form approved by the institutional review board for the protection of human subjects.

2.2. The dot-probe task

2.2.1. Emotion-inducing stimuli

Semi-structured interviews were conducted with five experienced archers to explore threatening and positive words related to archery events. The archers were asked to recall words, pictures, and scenes that could cause increased anxiety or stabilize emotional responses before or during competitions. According to the transcripts of these interviews, 125 threatening (e.g., score and limitation) and 125 positive terms (e.g., control and conquer) with only two Chinese characters were selected. Then, these two clusters of terms were separately presented in two questionnaires in random order. The emotional intensities of six experienced archers were evaluated according to a 9-point Likert type response scale (1 = not strong, 9 = very strong). Eventually, 36 threatening (e.g., tense, zero, and lost; mean intensity = 6.50 ± 0.75) and 36 positive terms (e.g., stable, relax, and energy; mean intensity = 6.94 ± 1.87) were chosen. For the stimuli related to threats, the Kendall's W was 0.428 and, for the stimuli related to positive information, the Kendall's W was 0.521. Given the high number of items analyzed (i.e., more than 100) and raters (i.e., 6 raters) on a 9-point Likert scales, both values indicate acceptable interrater reliability.

2.2.2. The modified dot-probe task

The task adopted in the present study was a modified dot-probe task (MacLeod et al., 1986). Each trial began with the presentation of a fixed cross at the center of a screen for 1000 ms. Then, a pair of emotion-inducing terms (i.e., a threatening cue and a positive cue) was displayed for 1000 ms. Following this, a target-probe appeared for 100 ms, after which the screen went blank. The target-probe display consisted of two dots and was oriented either horizontally or vertically, replacing the location of either the left or right cue. Participants were required

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