The Effect of Trait Anxiety on Pre-attentive Processing of Facial Expressions: Evidence from ERP

Authors: Li Wanyue, Liu Shen, Han Shangfeng, Zhang Lin, Xu Qiang, Xu Qiang

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Abstract

To investigate the processing patterns of emotional stimuli during the pre-attentive stage in high trait anxiety individuals and clarify their emotional bias characteristics, the present study employed a deviant-standard reversal Oddball paradigm to examine the effect of trait anxiety on the pre-attentive processing of facial expressions. The results demonstrated that for the low trait anxiety group, the early EMMN elicited by sad faces was significantly larger than that elicited by happy faces, whereas for the high trait anxiety group, no significant difference was observed between the early EMMN elicited by happy and sad faces. Furthermore, the amplitude of the happy face EMMN in the high trait anxiety group was significantly greater than that in the low trait anxiety group. These results indicate that personality traits constitute an important factor influencing the pre-attentive processing of facial expressions. Unlike normal subjects, high trait anxiety individuals exhibit similar processing patterns for happy and sad faces during the pre-attentive stage, potentially reflecting difficulty in effectively discriminating between happy and sad emotional faces.

Full Text

The Influence of Trait Anxiety on Pre-attentive Processing of Facial Expressions: Evidence from ERP

LI Wanyue[1],[2], **LIU Shen**[3], **HAN Shangfeng**[4], **ZHANG Lin**[1], **XU Qiang**[1]

[1] Department and Institute of Psychology, Ningbo University, Ningbo 315211, China
[2] School of Psychology, South China Normal University, Guangzhou 510631, China

[3] School of Humanities and Social Sciences, University of Science and Technology of China, Hefei 230022, China
[4] School of Psychology; Center for Brain Disorders and Cognitive Neuroscience, Shenzhen University, Shenzhen 518060, China

Abstract

To investigate the processing patterns of emotional stimuli during the pre-attentive stage in individuals with high trait anxiety and to clarify their emotional bias characteristics, this study employed a deviant-standard-reverse oddball paradigm to examine the influence of trait anxiety on pre-attentive processing of facial expressions. The results revealed that for the low trait anxiety group, the early EMMN amplitude elicited by sad faces was significantly larger than that by happy faces, whereas for the high trait anxiety group, no significant difference was observed between happy and sad faces in early EMMN amplitude. Moreover, the happy-face EMMN amplitude in the high trait anxiety group was significantly larger than that in the low trait anxiety group. These findings indicate that personality traits constitute an important factor affecting pre-attentive processing of facial expressions. Unlike typical participants, high trait anxiety individuals exhibit similar processing patterns for happy and sad faces during the pre-attentive stage, suggesting difficulty in effectively distinguishing between these emotional expressions.

Keywords: trait anxiety, pre-attentive processing, facial expressions, EMMN

1. Introduction

Facial expression processing is characterized by rapidity, automaticity, and unconsciousness [?, ?, ?]. However, researchers have found that individual factors such as gender, age, and personality traits can influence facial expression perception [?, ?, ?, ?]. Among these factors, trait anxiety—an important personality trait—demonstrates particular effects on facial expression processing. Previous studies have found that individuals with high trait anxiety, who experience persistent diffuse negative emotions, may develop attentional and memory biases, leading to preferential attention toward negative emotional faces [?, ?]. Nevertheless, other researchers have suggested that high trait anxiety individuals exhibit a general attentional bias toward emotionally salient stimuli rather than exclusively negative ones [?, ?, ?, ?].

Unlike conscious attention, pre-attentive processing represents an automatic evaluation of whether stimuli require attentional resources, filtering out vast amounts of irrelevant information to conserve cognitive resources and enhance processing efficiency [?, ?]. The mismatch negativity (MMN) component serves as a crucial index for investigating pre-attentive processing of stimulus information [?, ?]. Therefore, examining trait anxiety in conjunction with the MMN component can illuminate how high trait anxiety individuals filter and evaluate positive and negative emotions, clarifying whether emotional processing biases exist prior to attentional focus. Based on this rationale, the present study utilizes ERP technology to investigate the role of trait anxiety in pre-attentive processing of facial expressions and to examine the underlying mechanisms.

Trait anxiety represents a stable and enduring personality characteristic, wherein individuals with high trait anxiety are more likely to experience intense tension and anxiety in stressful situations [?, ?]. Compared to low trait anxiety individuals, those with high trait anxiety exhibit processing biases in attention, memory, and comprehension, which impair cognitive performance [?, ?, ?]. Dodd et al. (2017) employed an emotional face visual search task and found that individuals with higher trait anxiety scores showed attentional bias toward negative emotional faces, with trait anxiety scores correlating positively with attentional bias indices—indicating that high trait anxiety individuals allocate more attentional resources to negative faces and show heightened sensitivity to angry and fearful expressions. However, other researchers argue that high anxiety individuals over-amplify perceived emotional information, exhibiting general hyper-sensitivity to emotional stimuli rather than negativity-specific effects [?, ?, ?, ?].

Behavioral and neuroimaging evidence supports this hyper-sensitivity hypothesis. In a facial expression categorization task, Morel et al. (2014) investigated the role of trait anxiety in early-stage facial expression processing and found that happy faces elicited stronger activation in parieto-occipital regions of high trait anxiety individuals compared to neutral faces, whereas low trait anxiety individuals showed no such differences. This suggests that high trait anxiety individuals display distinctive activation patterns during happy face processing, supporting the notion of general hyper-sensitivity to emotional information. Additionally, Holmes et al. (2009) found that high trait anxiety individuals remained sensitive to emotional stimuli and exhibited larger LPP amplitudes even under high cognitive load, whereas low trait anxiety individuals did not. An fMRI study by Donges et al. (2012) similarly supported the general hyper-sensitivity hypothesis, revealing that attachment anxiety scores correlated positively with activation in left, central, and medial prefrontal regions during happy face processing—a finding relevant given the association between attachment anxiety and trait anxiety. Collectively, these studies suggest that high trait anxiety individuals exhibit not only negative emotion bias but also general hyper-sensitivity to emotional information including happy faces.

However, these studies focused on attentive processing stages, leaving unclear how trait anxiety affects pre-attentive processing of facial expressions. High trait anxiety individuals may engage in more complex cognitive processing of emotional stimuli prior to attentional focus, potentially manifesting different emotional biases on sensitive electrophysiological and neuroimaging measures compared to behavioral studies. Therefore, investigating trait anxiety's influence on pre-attentive facial expression processing can reveal how individuals filter and evaluate emotional stimuli during this stage, addressing controversies regarding emotional biases in attentional focus.

Research demonstrates that monitoring environmental stimulus changes occurs automatically [?, ?, ?]. MMN, derived by subtracting responses to standard stimuli (high-probability in oddball paradigms) from deviant stimuli (low-probability), reflects expectancy violation when repetitive patterns change, serving as a vital index of pre-attentive processing [?, ?]. Initially reported by Näätänen et al. (1978) in auditory oddball experiments, MMN typically comprises early and late subcomponents, with the early component reflecting sensory projection differences and the late component reflecting automatic processing of sensory memory [?, ?, ?]. Pulvermüller et al. (2003) demonstrated distinct activation patterns: temporal lobe activation around 136 ms and frontal cortex activation around 158 ms.

Recent MMN research has extended beyond auditory to visual stimuli, with simple visual features like gratings, colors, and lines eliciting MMN [?, ?, ?], and subsequently to complex visual stimuli such as facial expressions [?, ?, ?]. Studies show facial expression-elicited MMN occurs within 70-360 ms post-stimulus [?, ?, ?, ?, ?], with emotion-related MMN reliably detected in bilateral occipital regions [?, ?, ?]. Zhao and Li (2006) demonstrated automatic detection of emotional sequence changes, terming the ERP component derived from subtracting neutral standard from emotional deviant faces as EMMN (expressional MMN). Electrode selection typically includes P7/8, PO7/8, and CB1/2 in bilateral temporo-occipital regions [?, ?, ?, ?].

EMMN emerges approximately 100-400 ms after facial expression sequence changes [?, ?]. Kreegipuu et al. (2013) found that individuals automatically detect emotional sequence changes in schematic faces during pre-attention, with emotional faces eliciting larger EMMN amplitudes than neutral faces. However, debate persists regarding whether EMMN reflects emotional sequence violation or merely physical feature changes. Kimura et al. (2012) used upright and inverted standard/deviant facial expressions in an emotion-irrelevant task and found that deviant faces elicited EMMN, with fearful faces producing larger amplitudes and shorter latencies than happy faces, and upright conditions showing shorter latencies than inverted conditions. This indicates EMMN reflects prediction violation for whole faces and expressions, not merely structural features. Vogel et al. (2015) further validated EMMN' s specificity for emotional prediction, demonstrating that emotional deviants produced larger amplitudes and shorter latencies during emotional sequence changes, whereas structural feature changes did not. These findings provide evidence that EMMN reflects specific emotional sequence prediction errors.

If trait anxiety individuals exhibit special processing biases for emotional information during pre-attention, significant EMMN amplitude differences should emerge between high and typical participants when emotional sequences violate expectations. Previous EMMN research in special populations has focused primarily on psychiatric disorders such as schizophrenia and depression [?, ?, ?], with limited investigation of personality traits like trait anxiety. Anxiety-related studies have predominantly examined auditory processing under state anxiety induction [?, ?, ?]. For example, Schirmer and Escoffier (2010) found that angry voice deviants elicited larger MMN amplitudes than neutral voice deviants under state anxiety, with both MMN and heart rate increasing significantly with anxiety levels for angry but not neutral deviants. These findings demonstrate that high state anxiety individuals exhibit MMN and distinct neural activity to emotional deviants. Given that high trait anxiety individuals experience chronic diffuse anxiety, their pre-attentive processing of emotional stimuli may also be affected. However, since these studies did not include positive emotional stimuli, the processing bias of high trait anxiety individuals toward different valence emotions during pre-attention remains unclear.

Additionally, this study examined the N170 component, which is sensitive to facial configuration, to verify that faces were processed cognitively. The N170 component, distributed primarily in bilateral temporo-occipital regions, reflects structural encoding during early perceptual stages, peaking approximately 170 ms post-stimulus [?, ?]. Due to similarities in scalp distribution and temporal window with MMN, Astikainen et al. (2013) functionally dissociated these components: N170 showed emotion sensitivity between neutral and emotional faces but no difference for emotional sequence changes, whereas MMN differed both between neutral and emotional faces and across emotional sequence changes. Whether N170 is influenced by personality traits remains controversial. Some studies report larger N170 amplitudes for faces versus non-faces regardless of personality [?, ?, ?], while others find that high trait anxiety individuals show larger N170 amplitudes and shorter latencies when processing fearful faces [?, ?, ?]. Therefore, the processing of facial configuration features in trait anxiety individuals during pre-attention warrants investigation.

To explore processing patterns of emotional stimuli during pre-attention in high trait anxiety individuals and clarify their emotional bias characteristics, this study employed a deviant-standard-reverse oddball paradigm and ERP technology to examine pre-attentive processing characteristics and differences between high and low trait anxiety groups for emotional faces of different valences. We hypothesized that: (1) if individuals can automatically process facial expressions pre-attentively, differences between standard and deviant facial expressions in emotional sequences would produce N170 amplitude changes and elicit EMMN components; (2) if high trait anxiety individuals show negative emotion bias during pre-attention, they would differ from low trait anxiety individuals in EMMN amplitude for sad faces; if they show general emotion bias, they would differ for both happy and sad faces.

2. Methods

2.1 Participants

A total of 436 university students were assessed using the trait scale of the Spielberger State-Trait Anxiety Inventory (STAI) [?, ?]. Based on questionnaire scores, 20 participants scoring in the top 27% were randomly selected for the high trait anxiety group, and 20 scoring in the bottom 27% for the low trait anxiety group. The high trait anxiety group comprised 7 males and 13 females (mean age = 19.02 ± 0.63 years), while the low trait anxiety group included 9 males and 11 females (mean age = 19.63 ± 0.88 years). Independent samples t-test revealed significant differences between groups (high trait anxiety: M = 57.21, SD = 4.92; low trait anxiety: M = 30.64, SD = 3.83; t(38) = 19.632, $p < 0.001$). All participants had normal or corrected-to-normal vision, no color blindness, were right-handed, and had no personal or family history of psychiatric disorders. Participants were informed of the experimental procedures and provided written informed consent.

2.2 Materials

Facial expression pictures were selected from the Chinese Facial Affective Picture System (CAFPS) [?, ?], comprising 10 happy, 10 sad, and 10 neutral expressions (5 male and 5 female each). All images were converted to grayscale using Photoshop CS6 and matched for size, brightness, and contrast. External features (hair, ears) were removed, retaining only internal facial features (eyes, nose, mouth, cheeks).

2.3 Experimental Procedure

The deviant-standard-reverse oddball paradigm presented two identical emotional faces (happy, sad, or neutral) simultaneously on either side of a central fixation cross. Participants monitored unpredictable size changes of the fixation cross and responded via button press (J or F keys, counterbalanced across participants) as quickly and accurately as possible, while ignoring the facial expressions. Face stimuli were presented for 150 ms, with a 450 ms inter-stimulus interval. Target size changes of the fixation cross occurred only during intervals without face presentation to avoid contaminating ERP data with task-related activity. Deviant stimuli were low-probability faces (20%), while standard stimuli were high-probability faces (80%). The deviant-standard reversal meant that faces serving as deviants in some blocks became standards in others, and vice versa. Four facial expression sequence types were created: neutral standard/happy deviant, happy standard/neutral deviant, neutral standard/sad deviant, and sad standard/neutral deviant. Each type comprised 3 blocks, totaling 12 blocks per participant. Each block contained 412 face stimuli: 312 standard stimuli, 90 deviant stimuli, and 10 initial standard stimuli to establish sensory memory patterns. Block order was counterbalanced across participants. Stimuli were presented pseudorandomly, with deviants separated by at least two standards to establish emotional sensory memory and differentiate standard from deviant processing. The experimental procedure is illustrated in Figure 1 [Figure 1: see original paper].

The experiment was conducted in a sound-attenuated room with constant illumination and comfortable temperature. Participants sat 70 cm from the computer screen, maintaining fixation on the center while minimizing head movements, blinking, and swallowing.

2.4 Data Recording and Analysis

Stimulus presentation and behavioral data recording were controlled using E-Prime 2.0. EEG data were recorded using a NeuroScan Synamps2 system with a 68-channel Ag/AgCl electrode cap according to the international 10-20 extended system, along with vertical (VEOG) and horizontal (HEOG) electrooculograms. The nose tip served as reference. VEOG electrodes were placed 10 mm above and below the left eye, HEOG electrodes 10 mm lateral to the outer canthi. Data were acquired at 500 Hz sampling rate with 0.05-100 Hz bandpass filter, maintaining electrode impedance below 5 kΩ.

Offline analysis employed the EEGLAB toolbox [**?**, **?**]. A 0.5-30 Hz bandpass filter was applied. Epochs from 150 ms pre-stimulus to 400 ms post-stimulus were extracted, with the 150 ms pre-stimulus interval serving as baseline. Independent component analysis (ICA) was used to manually remove ocular artifacts, followed by exclusion of epochs exceeding \$±\$80 V. EEG signals were averaged for each condition. After obtaining waveforms for happy deviant, happy standard, sad deviant, and sad standard conditions, EMMN components were derived by subtracting standard from deviant waveforms for subsequent statistical analysis.

Based on previous research and examination of grand-averaged waveforms and scalp topographies, time windows and electrode sites were selected as follows: early EMMN (100-220 ms) and late EMMN (220-380 ms) at left hemisphere sites P7, PO5, PO7 and right hemisphere sites P8, PO6, PO8; N170 (150-190 ms) at left hemisphere P7, PO7 and right hemisphere P8, PO8. Repeated measures ANOVA was conducted using SPSS 25.

3. Results

3.1 Behavioral Data

Accuracy did not differ significantly between high and low trait anxiety groups, F(1, 38) = 0.37, p = 0.547 (high trait anxiety: M = 0.91, SE = 0.028; low trait anxiety: M = 0.92, SE = 0.023). With accuracy exceeding 90% and no significant group differences, participants' attention was successfully maintained on the fixation cross task, ensuring valid pre-attentive processing of facial expressions.

3.2 ERP Data

Two participants with excessive artifacts were excluded from each group. For the remaining data, a 2 (group: high vs. low trait anxiety) × 2 (emotion: happy vs. sad) × 2 (stimulus type: deviant vs. standard) × 2 (hemisphere: left vs. right) repeated measures ANOVA was conducted on N170 amplitudes. For early and late EMMN amplitudes, a 2 (group) × 2 (emotion) × 2 (hemisphere) repeated measures ANOVA was performed, with group as a between-subjects factor and other variables as within-subjects factors.

3.2.1 N170 A significant main effect of stimulus type emerged, F(1, 34) = 30.86, $p < 0.001$, ^{2}p = 0.476, with deviant stimuli (M = -1.55 V, SE = 0.20) producing significantly more negative amplitudes than standard stimuli (M = 0.51 V, SE = 0.14). Hemisphere main effect was significant, F(1, 34) = 5.38, p = 0.027, ^{2}p = 0.137. The hemisphere × group interaction was significant, F(1, 34) = 4.85, p = 0.035, ^{2}p = 0.125. Follow-up analyses revealed that in the high trait anxiety group, left hemisphere amplitudes were significantly more negative than right hemisphere (left: M = -0.217 V, SE = 0.23; right: M = 0.349 V, SE = 0.24, p = 0.003), whereas no hemisphere differences were observed in the low trait anxiety group. No other main effects or interactions were significant. Waveforms are presented in Figure 2 [Figure 2: see original paper].

3.2.2 EMMN For early EMMN (100–220 ms), a significant emotion × group interaction emerged, F(1, 34) = 4.34, p = 0.045, ^{2}p = 0.113. Simple effects analysis showed that for the high trait anxiety group, EMMN amplitudes did not differ between happy and sad conditions (happy: M = -0.74 V, SE = 0.17; sad: M = -0.62 V, SE = 0.21, $p > 0.05$). For the low trait anxiety group, sad faces elicited significantly larger EMMN amplitudes than happy faces (happy: M = -0.27 V, SE = 0.17; sad: M = -0.81 V, SE = 0.21, p = 0.021). Additionally, the high trait anxiety group showed marginally larger amplitudes than the low trait anxiety group for happy faces (high: M = -0.74 V, SE = 0.17; low: M = -0.27 V, SE = 0.17, p = 0.059). No other main effects or interactions were significant (ps > 0.05).

For late EMMN (220–280 ms), a significant group × hemisphere interaction was found, F(1, 34) = 4.55, p = 0.04, ^{2}p = 0.118. Simple effects analysis revealed no hemisphere differences in the high trait anxiety group (left: M = -0.57 V, SE = 0.15; right: M = -0.64 V, SE = 0.17, p = 0.456). In contrast, the low trait anxiety group showed significantly larger EMMN amplitudes in the left than right hemisphere (left: M = -0.70 V, SE = 0.15; right: M = -0.49 V, SE = 0.17, p = 0.03). No other main effects or interactions were significant (ps > 0.05). Waveforms and topographical maps are presented in Figure 3 [Figure 3: see original paper].

4. Discussion

Using happy and sad facial expressions in a deviant-standard-reverse paradigm, this study investigated pre-attentive processing of facial expressions and emotional bias characteristics in trait anxiety individuals. Behaviorally, participants demonstrated high accuracy in detecting fixation cross size changes, confirming that attention was maintained on the task unrelated to facial expressions and validating the pre-attentive manipulation. ERP results revealed N170 differences only for stimulus type, with deviants eliciting larger N170 amplitudes than standards, but no emotion effects. For early EMMN, low trait anxiety individuals showed larger amplitudes for sad than happy expressions, whereas high trait anxiety individuals showed no emotion difference. Moreover, the high trait anxiety group exhibited larger happy-face EMMN amplitudes than the low trait anxiety group. These findings demonstrate group differences in pre-attentive facial expression processing, suggesting that personality traits significantly influence this stage. High trait anxiety individuals appear to have difficulty distinguishing between happy and sad faces during pre-attentive processing, showing similar processing patterns for both emotions.

Previous research has established that N170 is face-sensitive and influenced by facial structure, showing differences across experimental conditions [**?**, **?**, **?**, **?**, **?**]. Astikainen et al. (2013) functionally dissociated N170 and MMN: N170 differed between neutral and emotional faces but was unaffected by emotional sequence changes, whereas MMN differed across emotional sequence changes. The present study’ s clear N170 peaks indicate that facial information entered cognitive processing. The significant stimulus type main effect, with deviants producing more negative amplitudes than standards, reflects complex cognitive components induced by experimental manipulation rather than differences in facial structure or emotion processing per se, as deviant and standard stimuli shared identical emotional content and structural features. Similar findings were reported by Kecskes-Kovacs et al. (2013) and Xu et al. (2013), where N170 was influenced only by stimulus type. Thus, the difference wave—EMMN—reflects detection of facial emotional sequence changes.

Both groups exhibited EMMN components induced by facial expression sequence changes, providing evidence for pre-attentive facial expression processing. The high trait anxiety group showed larger happy-face EMMN amplitudes than the low trait anxiety group, indicating special processing of emotional stimuli and a bias toward happy emotional information during pre-attention. The absence of emotion differences in EMMN for the high trait anxiety group contrasts with the low trait anxiety group, where sad expressions elicited larger early EMMN amplitudes than happy expressions. Previous research has repeatedly shown that negative information attracts attention preferentially due to survival needs, with negative facial expressions processed and recognized earlier [**?**, **?**, **?**]. The current findings indicate that this negative bias occurs during pre-attention in typical individuals. More importantly, high trait anxiety individuals show similar processing patterns for happy and sad faces during this stage, suggesting difficulty distinguishing between these expressions and consequently showing similar biases. Robinson et al. (2013) proposed that anxiety affects sensory cortex processing, making individuals more sensitive to environmental changes. The present study’ s findings—that high trait anxiety individuals show enhanced happy EMMN amplitudes and similar EMMN components for happy and sad faces—suggest they are sensitive to expectancy violations from positive emotions and exhibit similar processing patterns for both valences.

This phenomenon is corroborated in attentive processing stages. Li et al. (2019)

found that trait anxiety moderates facial emotion detection, with typical individuals showing significant context effects during emotion recognition, whereas high trait anxiety individuals focus more on facial emotion information itself across positive and negative faces, showing less context influence. This suggests that high trait anxiety individuals attend more to intrinsic facial emotion information and may have difficulty integrating facial and contextual emotions. The present findings support the general emotion bias observed in electrophysiological and neuroimaging studies during attentional focus [**?**, **?**, **?**], suggesting that difficulty distinguishing happy and sad expressions during pre-attention may allow happy emotions to enter attentional stages.

Xu et al. (2013) found differences between happy and sad expressions in both early and late EMMN subcomponents using schematic faces. In contrast, the present study found early EMMN affected by both emotion type and trait anxiety, whereas late EMMN was influenced only by trait anxiety, showing no hemisphere differences in the high trait anxiety group but larger left than right hemisphere amplitudes in the low trait anxiety group. This suggests different processing mechanisms for emotional information between groups. Additionally, as our participants were non-clinical individuals with high anxiety tendencies rather than anxiety disorder patients, experimental demands and cognitive load may have weakened emotion biases during later sensory memory processing [**?**, **?**]. Young and Bruce (2011) proposed that encoding of physical features and extraction of emotional information occur at different processing stages, and the differential effects of emotion type and trait anxiety on early versus late EMMN reflect the special nature of facial expression processing.

Chen et al. (2017) suggested that given MMN' s automatic nature, its amplitude could serve as a biological marker for trait anxiety levels and clinical diagnosis. Recent research indicates MMN may also serve as a neural marker for treatment efficacy in social anxiety disorder. Arad et al. (2018) found that attention bias modification training for social anxiety patients could elicit MMN, with amplitude predicting treatment outcome. Thus, as a marker of automatic information processing, MMN plays an increasingly important role in clinical diagnosis and treatment. The present study highlights trait anxiety as a personality factor influencing pre-attentive facial expression processing, revealing that high trait anxiety individuals are more sensitive to task-irrelevant emotional changes and show similar processing patterns for happy and sad faces. These findings enhance understanding of emotional filtering and evaluation modes in trait anxiety, with EMMN amplitude differences between groups reflecting automatic processing biases during pre-attention, thereby providing further experimental evidence for MMN' s clinical utility. Future research should investigate whether MMN can serve as a quantitative diagnostic and therapeutic indicator for anxiety and other neuroses, and whether pre-attentive hyper-sensitivity to emotional information affects more complex cognitive functions. Additionally, whether similar general emotion biases exist for emotional carriers from different modalities—such as emotional voices, body language, and tactile sensations—and whether MMN components across sensory modalities show differential patterns, warrant further investigation. Future studies could also dynamically examine MMN changes in conjunction with behavioral modification training.

This study has limitations. In the experimental design, button responses to the fixation cross target occurred only during intervals without face presentation, while ERP data were time-locked to face onset to minimize contamination from motor activity. However, if participants occasionally responded during face presentation, baseline stability could be affected—a consideration for future research.

In conclusion, trait anxiety influences pre-attentive processing of facial expressions. High trait anxiety individuals show similar processing patterns for happy and sad faces during pre-attention, with difficulty effectively distinguishing between these emotional expressions. Specifically, they exhibit enhanced EMMN amplitudes for both happy and sad faces, with larger happy-face EMMN amplitudes compared to low trait anxiety individuals.

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Note: Figure translations are in progress. See original paper for figures.

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