Self-Positive Expression Processing Advantage Effect: Evidence from ERPs Postprint

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Abstract

Based on the self-processing advantage and implicit positive association theory, the present study employed a visual search paradigm combined with ERPs technology to investigate the characteristics of self-face expression processing, and further explored the direct effects of emotional valence and identity information on face processing. The results revealed: (1) Searching for self-happy expressions was faster and more accurate than searching for self-angry expressions and both types of other expressions; (2) The activation of N1, N2, and LPP components elicited by self-happy expressions was significantly greater than that elicited by self-angry expressions and both types of other expressions. There exists a positive processing bias in self-face expression processing, and this processing advantage emerges as early as the early visual encoding stage of face processing.

Full Text

The Processing Advantage of Self-Positive Expressions: Evidence from ERPs

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Abstract

Based on the self-processing advantage and implicit positive association theory, this study employed a visual search paradigm combined with ERPs technology to investigate the characteristics of self-expression processing and to explore the direct effects of emotional valence and identity information on face processing. The results revealed: (1) Participants searched for self-happy expressions faster and more accurately than self-angry expressions and both types of other expressions; (2) Self-happy expressions elicited significantly greater activation of N1, N2, and LPP components compared to self-angry expressions and both types of other expressions. These findings demonstrate a positive processing bias in self-expression processing, with this advantage emerging as early as the initial visual encoding stage of face processing.

Keywords: self-expression; other-expression; visual search paradigm; implicit positive association theory; self-positivity bias
Classification: B842

1. Introduction

The self represents a unique psychological construct whose distinctiveness manifests in more rapid processing of stimuli associated with the self, a phenomenon researchers term the self-reference effect (Kim, 2012). Self-referential processing is influenced by the emotional valence of stimulus materials. For instance, individuals exhibit a positive processing bias toward stimuli of different emotional valences in self-referential contexts (Hoefler, Athenstaedt, Corcoran, Ebner, & Ischebeck, 2015; Zhong, Chen, Zhou, & Zhou, 2010), and self-referential processing varies under different emotional priming conditions (Zhou, Hu, Cai, Hu, & Liu, 2016). Notably, researchers have confirmed at the electrophysiological level that self-related information processing and emotional valence processing are not independent but rather interactive (Watson, Dritschel, Obonsawin, & Jentzsch, 2007; Chen, Zhong, Zhou, Zhou, & Wang, 2012; Zhong et al., 2010). However, previous studies have not directly examined the processing of self-related information with different emotional valences, instead manipulating self-information and emotional materials separately, which makes it difficult to reveal the joint effects of self and emotional valence on cognitive processing.

The present study used self-expression faces with different valences as stimuli to investigate the processing characteristics of self-expressions and to explore the processing patterns of self-expressions with different emotional valences, thereby revealing the roles of self-information and emotional valence in face processing. Processing self-expressions is not only a form of self-referential processing but also a special self-face processing process that highlights the distinction between self and others (Han & Zhang, 2012). In the domain of self-face processing, researchers have found that individuals exhibit an advantage effect in processing self-faces, manifested as faster identification of self-faces compared to other faces (Tong & Nakayama, 1999; Yun et al., 2014; Wang, Zhang, & Sui, 2011). Moreover, when perceiving self-faces, individuals receive priority access to attentional resources, which activates a larger frontocentral N2 negativity and larger late positive components (Guan, Qi, Zhang, & Yang, 2014; Yun et al., 2014; Zhong, Li, Zhan, Fan, & Yang, 2016). To explain this self-face processing advantage, some researchers have proposed the implicit positive association (IPA) theory (Ma & Han, 2010). According to this theory, self-face recognition is accompanied by self-awareness activity that more readily activates the positive attributes of one' s self-concept, thereby facilitating self-face processing and resulting in a processing advantage. Based on IPA theory, if the self-face processing advantage reflects activation of positive self-concept, can self-faces with different emotional valences all activate individuals' positive self-concept? For negative self-faces or self-negative expression faces, can they still demonstrate processing advantages by activating self-concept? This constitutes the first question addressed in this study.

Some researchers have proposed that the self-face recognition advantage arises from activation of positive self-concept, and when the positive attributes of self-concept are undermined, this advantage is weakened—an idea confirmed using self-concept threat paradigms (Guan, Zhang, Qi, Hou, & Yang, 2012). Other studies have found that negative self-threat stimuli (e.g., self-distorted faces) activate negative attributes of self-concept, thereby weakening the self-face recognition advantage (Xu & Gao, 2017). Additionally, previous research has revealed that individuals exhibit a positive bias when processing self-related information, tending to associate positive information with the self, known as self-positivity bias (Zhong et al., 2010). Verosky and Todorov (2010) found that people are more inclined to judge faces with positive attributes (e.g., more trustworthy faces) as their own; Hoefler et al. (2015) also found that in self-referential conditions, people respond faster to positive trait words than negative trait words. Based on IPA theory and self-positivity bias, this study proposes **Hypothesis 1:** Positive self-expressions more easily activate individuals' positive self-concept, thereby enhancing the processing advantage of self-expressions; whereas negative self-expressions, as a form of self-concept threat stimulus, hinder activation of positive self-concept and weaken the processing advantage of self-expressions. Compared to self-negative expressions, individuals identify self-positive expressions more quickly—that is, a processing advantage for self-positive expressions exists.

Self-expression processing involves both identity information processing and emotional valence processing of faces. Initially, Bruce and Young' s (1986) functional model for face recognition proposed that facial identity and emotional information processing constitute two parallel yet independent processing pathways. However, recent research has questioned this view, suggesting that facial identity processing and expression processing may influence each other, with identity' s influence on expression processing being particularly common (Wu, Zhang, & Sun, 2015). Some studies have also found that expression processing affects facial identity processing, as in eyewitness experiments where target individuals' expressions influence identity recognition (Pavel & Iordănescu, 2012).

However, these studies examining the relationship between facial expression and identity processing have lacked in-depth exploration of the "self" as a special identity. Previous research has found that the discriminability level between expression and identity is an important factor affecting their interaction (Wang & Fu, 2007), and the identity discriminability of self-faces is significantly higher than that of other faces (Han & Zhang, 2012). Therefore, the second question this study addresses is how identity information and emotional valence influence the processing when individuals process self-expressions—that is, how identity and emotional valence function at different stages of face processing.

Reviewing previous research reveals that during face perception, identity and emotional valence produce different effects at different processing stages. In the early visual encoding stage, facial expression processing is influenced by emotional valence. For example, the N1 component is closely related to attentional selection of emotional information, reflecting initial sensory encoding and attentional orientation, with emotional valence modulating the N1 component (around 130 ms) appearing in central-parietal regions (Foti, Hajcak, & Dien, 2009). Additionally, studies have found significant differences in the N170 component activated by faces of different emotional valences in the temporo-occipital region (Rellecke, Sommer, & Schacht, 2012). However, Sui, Zhu, and Han (2006) argue that the self-face processing advantage is unrelated to early processing stages and depends instead on later attention and evaluation stages (220–700 ms). Thus, it can be speculated that in the early visual encoding stage, facial expression processing is mainly influenced by emotional valence rather than self-identity information. In the middle stage, face processing is influenced by both emotional valence and identity information, as the N2 component in the frontocentral region (around 200–300 ms) is affected by expression valence (Feldmann-Wüstefeld, Schmidt-Daffy, & Schubö, 2011) and is also highly related to self-face processing, reflecting selective attention to stimuli (Guan et al., 2014; Yun et al., 2014). Furthermore, the late stage of face processing is also affected by identity and emotional valence. Studies have found that self-face recognition elicits larger LPP amplitudes than other faces, reflecting specific processing of self-related information (Yun et al., 2014). The LPP is a late positive slow wave that begins approximately 300–400 ms after stimulus presentation, lasting several hundred milliseconds and often peaking in central-parietal regions (Xia, Li, Ye, & Li, 2014). Meanwhile, Calvo and Beltrán (2013) found that positive expressions elicit larger LPPs than negative expressions, indicating that individuals engage in more refined high-level cognitive processing of positive expressions. Based on this analysis, this study proposes that when processing self-expressions, the process is jointly influenced by self-information and emotional valence, but their roles may differ across processing stages. Therefore, using N1, N170, N2, and LPP components as indices, this study examines the processing of self and other expressions with different emotional valences and the roles of self-information and emotional valence in face processing, leading to **Hypothesis 2:** In the early visual encoding stage, facial expression processing is only influenced by emotional valence; in subsequent processing stages, emotional valence and identity information interact.

Traditional face processing research using expression recognition judgment tasks is not conducive to highlighting the intrinsic attributes of expression stimuli and has low ecological validity. In contrast, the visual search paradigm requires participants to search for target stimuli from distractor stimuli, examining which facial expression stimuli are more likely to stand out among distractors and capture early attentional orientation (Tong & Nakayama, 1999). Therefore, this study adopted the visual search paradigm combined with ERP technology, which has high temporal resolution, using correct search reaction times, accuracy rates, and ERP components (N1, N170, N2, LPP) as indices to examine the process and characteristics of self-expression processing, to verify whether a processing advantage for self-expressions exists in face recognition, and to further explore the processing of self and other expressions with different emotional valences to reveal the influence of identity and emotional valence in face processing.

2. Method

2.1 Participants Twenty-five college students were recruited (11 males, 14 females; mean age = 19.85 years, SD = 1.16). All participants had normal vision and hearing, were right-handed, had no prior experience with similar experiments, and had no history of psychiatric or brain disorders. They could normally match expression pictures with emotional label words and operate computers proficiently. All participated voluntarily and received compensation after the experiment.

2.2 Materials and Apparatus Self-expression pictures were created following the methodology of the Chinese Facial Affective Picture System (CAFPS) (Gong, Huang, Wang, & Luo, 2011). Using the same digital camera (Nikon S8200) under identical lighting and shooting conditions, photographs were taken of each participant displaying happy and angry expressions, yielding 50 color pictures (RGB). Other-expression pictures were selected from CAFPS, including 6 happy expressions, 6 angry expressions, and 30 neutral expressions, with equal gender distribution (Gong et al., 2011). All pictures were uniformly processed in PhotoShop CS 6, converted to grayscale, sized at 472×545 pixels, 24-bit bitmaps, with matched brightness and contrast. All facial materials had hair, ears, and other external features removed, retaining only internal facial features (eyes, nose, mouth, cheeks, etc.). Example materials are shown in Figure 1 [Figure 1: see original paper].

Figure 1. Examples of self (left two) and other (right two) expressions

An additional 45 college students (equal gender distribution) who did not participate in the main experiment rated the valence, intensity, and arousal of self-expression pictures on 9-point scales and evaluated their recognizability. The statistical power of this rating assessment was 0.9. Results showed that self-happy expressions had mean valence of 6.05 (SD = 0.93), mean intensity of

6.44 (SD = 1.09), and mean arousal of 6.06 (SD = 1.33); self-angry expressions had mean valence of 3.54 (SD = 0.96), mean intensity of 6.37 (SD = 0.99), and mean arousal of 6.13 (SD = 1.36). Recognizability for each self-expression picture exceeded 80%. Self-happy and self-angry expressions differed significantly in valence (t(44) = 55.16, $p < 0.001$, d = 2.69) but not in intensity (t(44) = 1.58, p = 0.122) or arousal (t(44) = -0.90, p = 0.372). Other-happy (5.95 ± 0.46) and other-angry (3.62 ± 0.12) expressions also differed significantly in valence (t(10) = 11.87, $p < 0.001$, d = 7.59) but not in intensity (6.38 ± 0.06 vs. 6.41 ± 0.10; t(10) = -0.76, p = 0.464) or arousal (5.86 ± 0.82 vs. 6.07 ± 0.50; t(10) = -0.54, p = 0.598). Self-happy and other-happy expressions did not differ significantly in valence (t(29) = 0.94, p = 0.356), intensity (t(29) = 0.93, p = 0.358), or arousal (t(29) = 1.32, p = 0.197). Similarly, self-angry and other-angry expressions showed no significant differences in valence (t(29) = -1.49, p = 0.147), intensity (t(29) = -0.85, p = 0.403), or arousal (t(29) = 0.55, p = 0.590). Additionally, each self-happy expression material did not differ significantly from other-happy expressions in valence, intensity, or arousal (all $ps > 0.05$), and the same held for self-angry versus other-angry expressions (all $ps > 0.05$). Recognizability did not differ significantly between self-expressions (83.06 ± 3.31) and other-expressions (81.48 ± 5.20), t(90) = 1.79, p = 0.077.

2.3 Experimental Design The experiment used a 2 (expression type: happy vs. angry) × 2 (identity type: self vs. other) within-subjects design. Dependent variables included expression judgment reaction time, accuracy, and ERP data (mean amplitudes or peak values of N1, N170, N2, and LPP components).

2.4 Procedure E-Prime 2.0 software was used to present stimuli and record behavioral data. The visual search paradigm presented search arrays arranged in a circular pattern, requiring participants to quickly judge whether target expression stimuli were present. A fixation cross "+" appeared at the center of the screen for 500 ms, followed by a 300 ms blank screen. Then six faces were presented at six positions on the screen (one target expression face with five neutral faces, or six neutral faces). Participants were instructed to judge whether a target expression appeared on the screen. If a target expression appeared, they pressed the "F" key; if all faces were neutral, they pressed the "J" key. After the response, there was a random interval of 600–800 ms before the next trial began; if no response occurred within 3000 ms, the next trial began automatically (see Figure 2 [Figure 2: see original paper]). The viewing distance was 65 cm, and face pictures subtended a visual angle of 14.47° × 10.55°.

Figure 2. Flowchart of a single trial in the experimental procedure

The entire experiment consisted of 464 trials, including 32 practice trials, 216 filler trials (six neutral faces), and 54 trials for each experimental condition. The formal experiment was divided into two blocks: a happy expression search block and an angry expression search block, with presentation order counterbalanced across participants. Each target expression face appeared randomly at the six positions, with each self-expression face appearing six times at each position and each other-expression face (same gender) appearing three times at each position.

2.5 EEG Recording and Analysis EEG data were recorded and analyzed using a NeuroScan Synamps2 system. EEG was recorded from 64 scalp sites according to the international 10-20 system extended electrode cap, along with horizontal electrooculography (HEOG) and vertical electrooculography (VEOG). HEOG electrodes were placed 10 mm lateral to the outer canthi, and VEOG electrodes were placed 10 mm above and below the left eye. The nose tip served as the reference electrode, with the forehead grounded. The sampling rate was 1000 Hz/channel, with a bandpass filter of 0.01-100 Hz. Impedance between electrodes and scalp was maintained below 5 kΩ.

NeuroScan 4.3 software was used for offline EEG analysis. After behavioral data integration and EEG preview, six participants with excessive artifacts were excluded, leaving 19 valid participants (8 males, 11 females). Ocular artifacts caused by eye movements or blinks were then removed (Gratton, Coles, & Donchin, 1983). The EEG analysis epoch was 1200 ms, from 200 ms before to 1000 ms after face stimulus presentation, with a 200 ms pre-stimulus baseline. Epochs with amplitudes exceeding ±100 V were automatically rejected as artifacts. EEGs for correct responses under each of the four experimental conditions were then averaged separately for each participant, with valid superposition times exceeding 45 trials (more than 80% of total trials). Finally, the obtained ERP data were filtered using an FIR digital filter with a 30 Hz (24 dB/octave) zero-phase-shift low-pass filter.

Based on the research purpose, previous findings, and the waveform characteristics of grand-averaged waveforms and topographic maps in this study, ERP components and electrode positions were selected, resulting in 25 electrode sites. Specifically: N1 (50-150 ms, left hemisphere F1/FC1/C1/CP1, midline Fz/FCz/Cz/CPz, right hemisphere F2/FC2/C2/CP2) peak amplitude and latency; N170 (120-200 ms, left hemisphere P7/PO7/CB1, right hemisphere P8/PO8/CB2) peak amplitude and latency; N2 (230-330 ms, left hemisphere F1/FC1/C1/CP1, midline Fz/FCz/Cz/CPz, right hemisphere F2/FC2/C2/CP2) peak amplitude and latency; and LPP (400-800 ms, left hemisphere F1/FC1/C1/CP1/P1, midline Fz/FCz/Cz/CPz/Pz, right hemisphere F2/FC2/C2/CP2/P2) mean amplitude.

Data for each selected ERP component were subjected to multi-factor repeated-measures ANOVA, with expression type (happy vs. angry), identity type (self vs. other), and brain region as within-subject variables. All p-values were corrected using the Greenhouse-Geisser method.

3. Results

3.1 Behavioral Results Incorrect responses and reaction times less than 100 ms or greater than 3000 ms were removed (Tong & Nakayama, 1999), accounting for 9.47% of total data. Descriptive statistics for reaction times and accuracy rates across experimental conditions are shown in Table 1 .

Table 1. Reaction times (ms) and accuracy rates (%) for expression judgment under each experimental condition (M ± SD)

For accuracy rates, the main effect of identity type was significant, F(1, 24) = 16.48, $p < 0.001$, ^{2}p = 0.41. Accuracy for searching self-expressions (M = 96.94, SD = 3.78) was significantly higher than for other-expressions (M = 92.72, SD = 7.19), t(24) = 4.24, $p < 0.001$, d = 0.75. Neither the main effect of expression type (F(1, 24) = 3.78, p = 0.064) nor the interaction (F(1, 24) = 1.81, p = 0.191) was significant.

For reaction times, the main effect of identity type was significant, F(1, 24) = 178.89, $p < 0.001$, ^{2}p = 0.14. Searching for self-expressions (M = 805.81, SD = 299.51) was significantly faster than searching for other-expressions (M = 912.95, SD = 355.11), t(24) = 10.81, $p < 0.001$, d = 0.33. The main effect of expression type was also significant, F(1, 24) = 691.67, $p < 0.001$, ^{2}p = 0.39. Searching for happy expressions (M = 739.09, SD = 240.98) was significantly faster than searching for angry expressions (M = 979.66, SD = 368.16), t(24) = 28.56, $p < 0.001$, d = 0.79. The interaction between identity and expression type was significant, F(1, 24) = 47.10, $p < 0.001$, ^{2}p = 0.04.

Simple effects analysis revealed that self-expression search was significantly faster than other-expression search for both happy expressions (F(1, 24) = 40.63, $p < 0.001$, ^{2}p = 0.04) and angry expressions (F(1, 24) = 140.64, $p < 0.001$, ^{2}p = 0.12). Additionally, happy expression search was significantly faster than angry expression search for both self-expressions (F(1, 24) = 264.42, $p < 0.001$, ^{2}p = 0.20) and other-expressions (F(1, 24) = 537.28, $p < 0.001$, ^{2}p = 0.33). These results indicate that individuals exhibit both a self-expression processing advantage and a positive expression processing advantage during face expression processing, manifesting as a processing advantage for self-positive expressions.

3.2 ERP Results Grand-averaged ERP waveforms and topographic maps for the four target expression stimuli at frontocentral, parietal, and temporo-occipital electrodes are shown in Figure 3 [Figure 3: see original paper].

3.2.1 N1 (50-150 ms) A 2 (expression type: happy, angry) × 2 (identity type: self, other) × 3 (brain region: left hemisphere F1/FC1/C1/CP1, midline Fz/FCz/Cz/CPz, right hemisphere F2/FC2/C2/CP2) repeated-measures ANOVA was conducted on N1 peak amplitude and latency.

For amplitude, the main effect of identity type was significant, F(1, 18) = 27.44, $p < 0.001$, ^{2}p = 0.60. Self-expressions elicited significantly larger amplitudes (-3.14 ± 0.92 V) than other-expressions (-1.87 ± 1.13 V), t(18) = 5.24, $p < 0.001$, d = 1.27. The main effect of expression type was significant, F(1, 18) = 44.42, $p < 0.001$, ^{2}p = 0.71. Happy expressions elicited larger amplitudes (-3.20 ± 0.83 V) than angry expressions (-1.83 ± 1.12 V), t(18) = 6.67, $p < 0.001$, d = 1.43. The interaction between identity and expression type was significant, F(1, 18) = 4.53, p < 0.05, ^{2}p = 0.20. Simple effects analysis showed that self-expressions elicited significantly larger N1 amplitudes than other-expressions for both happy and angry expressions (p < 0.05). For self-expressions, happy expressions elicited significantly larger amplitudes than angry expressions (p < 0.001), but for other-expressions, the difference between happy and angry expressions was not significant (p = 0.108). No other main effects or interactions were significant (all ps > 0.05).

For latency, the interaction between identity and expression type was significant, F(1, 18) = 4.39, p < 0.05, ^{2}p = 0.06. Simple effects analysis revealed that self-happy expressions elicited significantly shorter N1 latencies than self-angry expressions (p < 0.01), but other-happy and other-angry expressions did not differ significantly (p = 0.893). No significant differences existed between self and other expressions for either happy or angry expressions (all ps > 0.05). No other main effects or interactions were significant (all ps > 0.05).

3.2.2 N170 (120-200 ms) A 2 (expression type: happy, angry) × 2 (identity type: self, other) × 2 (brain region: left hemisphere P7/PO7/CB1, right hemisphere P8/PO8/CB2) repeated-measures ANOVA was conducted on N170 peak amplitude and latency.

For amplitude, the main effect of expression type was significant, F(1, 18) = 10.53, p < 0.01, ^{2}p = 0.16. Happy expressions elicited larger amplitudes (-5.21 ± 5.36 V) than angry expressions (-3.68 ± 5.67 V), t(18) = 3.25, p < 0.01, d = 0.28. No other main effects or interactions were significant (all ps > 0.05).

For latency, the main effect of expression type was significant, F(1, 18) = 6.27, p < 0.05, ^{2}p = 0.10. Happy expressions elicited significantly shorter N170 latencies than angry expressions. No other main effects or interactions were significant (all ps > 0.05).

3.2.3 N2 (230-330 ms) A 2 (expression type: happy, angry) × 2 (identity type: self, other) × 3 (brain region: left hemisphere F1/FC1/C1/CP1, midline Fz/FCz/Cz/CPz, right hemisphere F2/FC2/C2/CP2) repeated-measures ANOVA was conducted on N2 peak amplitude and latency.

For amplitude, the main effect of identity type was significant, F(1, 18) = 21.74, p < 0.001, ^{2}p = 0.19. Self-expressions elicited larger amplitudes (-6.17 ± 4.61 V) than other-expressions (-5.41 ± 4.66 V), t(18) = 4.66, p < 0.001, d = 0.17. The main effect of expression type was significant, F(1, 18) = 42.37, p < 0.001, ^{2}p = 0.31. Happy expressions elicited larger amplitudes (-6.92 ± 4.27 V) than angry expressions (-4.65 ± 4.74 V), t(18) = 6.51, p < 0.001, d = 0.52. Further comparison of the four expression stimuli revealed that self-happy expressions elicited larger amplitudes (-7.33 ± 4.20 V) than self-angry (-5.00 ± 4.66 V), other-happy (-6.51 ± 4.24 V), and other-angry expressions (-4.31 ± 4.76 V; all ps < 0.001). The main effect of brain region was significant, F(2, 36) = 34.80,

$p < 0.001$, ^{2}p = 0.18. Multiple comparisons showed that expression stimuli elicited larger amplitudes in the midline region (-6.10 ± 4.73 V) than in the left (-5.61 ± 4.50 V) and right hemispheres (-5.65 ± 4.70 V; all ps < 0.001), with no significant difference between left and right hemispheres (p = 0.664). The interaction between identity type and brain region was significant, F(2, 36) = 9.70, $p < 0.001$, ^{2}p = 0.09. Simple effects analysis showed that self-expressions elicited larger amplitudes than other-expressions in all brain regions (all ps < 0.001), and that expression stimuli elicited larger amplitudes in the midline region than in left and right hemispheres for both self and other expressions (all ps < 0.001). No other interactions were significant (all ps > 0.05).

For latency, the main effect of expression type was significant, F(1, 18) = 25.72, $p < 0.001$, ^{2}p = 0.26. Angry expressions elicited shorter N2 latencies than happy expressions. No other interactions were significant (all ps > 0.05).

3.2.4 LPP (400-800 ms) A 2 (expression type: happy, angry) × 2 (identity type: self, other) × 3 (brain region: left hemisphere F1/FC1/C1/CP1/P1, midline Fz/FCz/Cz/CPz/Pz, right hemisphere F2/FC2/C2/CP2/P2) repeated-measures ANOVA was conducted on LPP mean amplitude.

The main effect of identity type was significant, F(1, 18) = 80.75, $p < 0.001$, ^{2}p = 0.46. Self-expressions elicited larger amplitudes (1.38 ± 2.73 V) than other-expressions (0.49 ± 2.42 V), t(18) = 8.99, $p < 0.001$, d = 0.35. The main effect of expression type was significant, F(1, 18) = 68.62, $p < 0.001$, ^{2}p = 0.42. Happy expressions elicited larger amplitudes (1.48 ± 2.78 V) than angry expressions (0.39 ± 2.33 V), t(18) = 8.28, $p < 0.001$, d = 0.44. The interaction between identity and expression type was significant, F(1, 18) = 27.21, $p < 0.001$, ^{2}p = 0.22. Simple effects analysis revealed that self-expressions elicited larger amplitudes than other-expressions for both happy and angry expressions (all ps < 0.001), and happy expressions elicited larger amplitudes than angry expressions for both self and other expressions ($p < 0.001$). No other main effects or interactions were significant (all ps > 0.05).

Figure 3. Grand-averaged ERP waveforms and topographic maps for self-expression and other-expression processing (Color figure available in online version)

4. Discussion

4.1 Processing Advantage of Self-Positive Expressions This study investigated the processing characteristics of self-expressions using visual search paradigm and ERP technology. Behavioral results showed that searching for self-expressions was significantly faster and more accurate than searching for other-expressions, demonstrating a self-expression processing advantage; additionally, searching for happy expressions was significantly faster and more accurate than searching for angry expressions, demonstrating a positive expression processing advantage. Among all expressions, self-happy expressions were searched fastest and most accurately, showing a processing advantage for self-positive expressions in behavioral measures. ERP results further revealed that self-happy expressions elicited larger N1, N2, and LPP components than other expressions, also demonstrating a processing advantage for self-positive expressions. Overall, these findings indicate that individuals process facial expressions with different identity and emotional valence information differently, showing a processing advantage for self-expressions, particularly self-positive expressions. This verifies our hypothesis regarding the processing advantage effect of self-positive expressions and aligns with previous research showing processing advantages for self-related information and self-positive bias (Kim, 2012). Moreover, these results further confirm IPA theory: self-positive expressions, compared to self-negative expressions, better activate positive attributes of self-concept, thereby enhancing cognitive processing and behavioral responses to self-faces and demonstrating recognition advantages for self-positive expressions. For individuals, self-expression processing is not only a way to understand self-emotion representation but also involves self-evaluation and emotional experience. The processing advantage of self-positive expressions reflects both individuals' positive processing preference for self-information and the general processing characteristics of self-related information (Zhong et al., 2010).

4.2 Perceptual Processing of Self-Expressions ERP results showed that self-expressions elicited larger N1, N2, and LPP components than other-expressions, and happy expressions elicited larger N1, N2, N170, and LPP amplitudes and shorter N170 latencies than angry expressions. Self-happy expressions activated significantly larger N1, N2, and LPP amplitudes than self-angry and other expressions.

The early N1 component reflects initial sensory encoding and attentional orientation of information and is related to visual-spatial attention. This study found that self-positive expressions elicited larger frontocentral N1 components than other expressions. Previous research suggested that self-face processing advantages occurred only in the attention and evaluation stage (220–700 ms), eliciting larger frontocentral positive waves unrelated to early encoding (Sui et al., 2006). However, by integrating self-information with facial emotional valence, this study discovered a processing advantage for self-positive expressions in the early encoding stage. According to IPA theory, this may be because self-positive expressions activate individuals' positive self-concept, accelerating attentional orientation to self-positive information, while the combination of self-identity and positive emotion may strengthen priority cognitive processing of such stimuli. Additionally, this study found that self-positive expressions elicited shorter N1 latencies than self-negative expressions, an early accelerated orientation not observed for other-positive expressions, reflecting the uniqueness of processing self-emotion information. The visual search paradigm used in this study required participants to quickly search for target expression faces among six neutral faces, whereas Sui et al. (2006) used single faces without search orientation, which may explain the discrepancy with previous results. Meanwhile, the N170 component, another early component reflecting structural encoding of expressions, showed no significant differences between self and other expressions in the temporo-occipital region. Some researchers consider N170 a mixed product of structural encoding and feature processing unaffected by face familiarity (Gosling & Eimer, 2011). Both implicit and explicit processing of emotional faces can elicit larger N170 amplitudes than neutral faces (Rellecke et al., 2012), though no consistent conclusion exists regarding which expressions elicit larger amplitudes (Xia et al., 2014). This study found that happy expressions elicited larger N170 amplitudes and shorter latencies than angry expressions, possibly related to diagnostic regions: angry expression information primarily comes from the eyes, while happy expression information mainly comes from the mouth. Calvo and Beltrán (2014) found that the mouth region of happy expressions becomes salient beginning 150 ms after stimulus presentation, eliciting larger brain waves in the 150–180 ms temporo-occipital region, suggesting the mouth may be a shortcut for recognizing happy faces. Overall, in early components, only self-positive expressions showed significant differences in N1 compared to other expressions, indicating that the early-stage processing advantage for self-positive expressions primarily reflects prioritized attentional orientation to self-positive expressions rather than advantages in expression structural encoding.

In self-face processing research, the N2 component is considered highly related to self-face processing (Guan et al., 2014; Yun et al., 2014) and is typically associated with attentional switching mechanisms, being susceptible to stimulus intensity and arousal (Feldmann-Wüstefeld et al., 2011). Despite matching expression intensity and arousal, this study still found that self-expressions elicited larger N2 amplitudes than other-expressions, happy expressions elicited larger N2 amplitudes than angry expressions, and angry expressions elicited shorter N2 latencies than happy expressions. This suggests that self-expressions and happy expressions have psychological salience for individuals, commanding more attentional resources. Although happy expression processing was relatively delayed compared to angry expressions at this stage, it was more elaborate and in-depth, occupying more attentional resources. No interaction between identity and expression information was found for the N2 component, possibly because at this stage, the brain’ s processing of these two types of information remains coarse, involving only rapid differentiation, with more refined cognitive processing combining both types of information occurring at later stages (Zhong et al., 2016). Self-happy expressions elicited larger N2 amplitudes than other expressions, indicating that the processing advantage for self-positive expressions persists in the middle stage of face processing.

In emotion research, the LPP component reflects sustained attention, conscious evaluation, and elaborate processing of emotional stimuli (Xia et al., 2014). ERP studies in self research have also found that self-face stimuli elicit larger LPP amplitudes, reflecting specific processing of self-related information (Yun et al., 2014). This study found that self-positive expressions elicited larger LPPs than other expressions, indicating that self-positive expressions occupy more attentional resources, involve higher degrees of self-involvement, and receive more elaborate processing. This not only confirms that individuals rapidly and elaborately process information related to self-concept (Kim, 2012) but also further supports IPA theory: activation of positive self-concept produces processing advantages for self-positive expressions.

The ERP results of this study demonstrate that self-positive expressions maintain an advantage throughout face expression processing, with this advantage already present in the early visual encoding stage, manifesting as rapid attentional orientation to self-positive expressions. Compared to other expressions, self-positive expressions are more psychologically salient and can preemptively occupy more attentional resources to complete subsequent elaborate processing activities.

4.3 Summary and Outlook In summary, this study used ERP technology to explore the cognitive processing of self-expressions and, combining self-positivity bias, proposed the processing advantage effect of self-positive expressions. This not only extends self-face processing research but also further expands and refines theories of self-face advantage effects, demonstrating that self-expression processing represents an important manifestation of the uniqueness of self-processing. Unlike previous self-face processing studies, this study found that the advantage effect of self-positive expressions begins in the early stage of face processing, indicating that the uniqueness of processing self-emotion information is manifested not only in later cognitive evaluation but also in early attentional orientation. Furthermore, the processing significance of self-expressions differs from that of other-expressions: self-expression processing is connected to self-concept and reflects individuals' cognition and evaluation of self-emotion representation. Therefore, this study' s exploration of self-expression processing characteristics also contributes to deeper understanding of self-cognitive processing mechanisms.

However, this study has several limitations. First, although the repetition frequency of self-expression materials was higher than that of other-expression materials in the formal experiment, supplementary experiments demonstrated that participants' behavioral responses were not affected by repetition frequency, though no direct evidence exists regarding whether repetition frequency affected ERP results. Second, this study did not control for face familiarity, which cannot be completely ruled out as a confounding factor. Future research could incorporate expressions of important or familiar others to control for familiarity and other irrelevant factors. Additionally, this study used expression stimuli of different identities to explore the relationship between facial identity and expression information. The results not only found that self-expression processing was faster and more accurate than other-expression processing but also that expression valence affected different identities differently: processing speeds for self-expressions of different valences differed significantly, with self-happy expressions processed significantly faster than self-angry expressions, demonstrating a processing advantage for self-positive expressions that supports IPA theory. However, whether the slower processing of self-angry expressions is solely due to threat to positive self-concept attributes weakening the self-processing advantage requires further investigation. Future research could manipulate self-concept threat priming to weaken the association between self-concept and positive attributes and examine whether the processing advantage for self-expressions persists under self-concept threat conditions to further explore the underlying mechanisms (Ma & Han, 2010). Moreover, since expression and identity recognition are affected by facial physical properties (e.g., high vs. low spatial frequency, face inversion or rotation), future research could further investigate the stability of the processing advantage for self-positive expressions.

5. Conclusions

This study reached the following main conclusions:

1. Individuals exhibit a processing advantage for self-positive expressions, manifested as faster and more accurate searching for self-happy expressions compared to self-angry expressions and both types of other expressions.
2. This advantage begins in the early visual encoding stage and is also manifested in subsequent processing stages, primarily shown by significantly larger N1, N2, and LPP amplitudes elicited by self-happy expressions compared to self-angry expressions and both types of other expressions.

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