

Perceiving Facial Emotions in Context: The Intertwined Roles of Emotional Valence and Consciousness

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Facial emotion perception in real life is inevitably influenced by the affective context, such as the expressions on nearby people's faces. However, to what extent and how the expressions of others exert a contextual influence on our interpretation of target facial emotions remains largely unclear. Using psychophysical methods, we demonstrated that the emotional facial context alone (i.e., without any evident social interaction cues) is sufficient to bias the perceived expression of an ambiguous target face ($N = 160$, healthy Asian college students, 2017–2025). Intriguingly, the contextual effect induced by faces with fearful, but not happy, expressions was regulated by observers' awareness of the context. For fearful contexts, the contextual effect showed a dissociation between nonconscious and conscious conditions, occurring only when the contextual face was not consciously perceived. By contrast, contextual faces expressing happiness biased emotion perception regardless of awareness. These findings broaden our understanding of the affective contextual effect in situations without explicit social relationships. More crucially, they unveil the intertwined roles of emotional valence and consciousness in emotional information integration, offering valuable insights into the intricate mechanisms whereby affective context shapes facial emotion perception.

Keywords: facial emotion perception, affective contexts, emotional valence, consciousness

Supplemental materials: <https://doi.org/10.1037/emo0001581.supp>

Accurate facial emotion perception is essential for human survival and adaptation to the social environment. Conventional wisdom holds that facial emotions are highly recognizable and can be adequately perceived from isolated facial configurations (Adolphs, 2002; Ekman, 1992; Russell, 1980). However, in real life, faces usually convey ambiguous emotional messages that could be misinterpreted without meaningful contexts (de Gelder et al., 2006; Fernández-Dols & Crivelli, 2013). Emerging evidence suggests that the perceived facial expressions are indeed heavily, or even automatically influenced by the contexts, known as the affective contextual effect (Aviezer et al., 2017; Barrett et al., 2011; Z. Chen & Whitney, 2019; Y. Chen et al., 2022; Hadders-Algra, 2022; Hassin et al., 2013; Wieser & Brosch, 2012).

One of the most common contextual cues for human facial emotion perception is the faces of others, as we frequently see people in crowds interacting with each other (Wieser & Brosch, 2012). However, it is not yet clear how the facial expressions of other people influence the perception of emotions in target faces. In an early study, Russell and Fehr (1987) found that after observers rated the emotion of a simultaneously presented contextual face, their classification of a target face's emotion was displaced in the opposite direction of the context, resulting in a contrast effect. Nonetheless, employing single target rating or emotion identification/categorization tasks, further studies have yielded attraction effects, that is, the recognition of diagnostic emotion on a target face was facilitated by target-context congruency (Fenske & Eastwood, 2003; Masuda et al., 2008;

This article was published Online First August 25, 2025.

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The authors report how they determined their sample size, all data exclusions (if any), all manipulations, and all measures in the study, and they follow Journal Article Reporting Standards. This study's design and data analysis were not preregistered. All data and analysis code are publicly available on the knowledge repository of the Institute of Psychology, Chinese Academy of Sciences, at <https://ir.psych.ac.cn/handle/311026/47455> (Y. Chen et al., 2025).

The authors have no conflicts of interest to declare with respect to the publication of this article. This research was supported by grants from the Ministry of Science and Technology of China (Grants 2021ZD0204200 and 2021ZD0203800 awarded to Ying Wang and Yi Jiang, respectively), the National Natural Science Foundation of China (Grants 32171059 and 32430043 awarded to Ying Wang and Yi Jiang, respectively), the Interdisciplinary Innovation Team (Grant JCTD-2021-06 awarded to Yi Jiang),

the Youth Innovation Promotion Association of the Chinese Academy of Sciences (awarded to Ying Wang), the Fundamental Research Funds for the Central Universities (awarded to Yi Jiang), the China Postdoctoral Science Foundation (Grant 2024M752310 awarded to Yujie Chen), and Jiangsu Funding Program for Excellent Postdoctoral Talent (Grant 20242B496 awarded to Yujie Chen).

Yujie Chen played a lead role in methodology, software, data curation, formal analysis, investigation, visualization, funding acquisition, and writing—original draft. Yi Jiang played a supporting role in funding acquisition, supervision, and writing—review and editing. Ying Wang played a lead role in conceptualization, methodology, funding acquisition, supervision, and writing—review and editing.

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Mumenthaler & Sander, 2012; Schulte Holthausen et al., 2016). Crucially, numerous studies have shown that the emergence of such contextual effects is contingent on specific conditions. For instance, Masuda et al. (2008) demonstrated that the influence of surrounding faces on recognizing emotion in a target face was evident among Japanese, but not Western observers, suggesting that cultural differences modulate the affective contextual effects. Besides, characteristics of the emotional faces, such as emotional valence and gaze directions, also play a role in these contextual effects. In particular, contextual modulation was more pronounced for happy contexts while less evident for negative valence (e.g., fear; Fenske & Eastwood, 2003; Schulte Holthausen et al., 2016). Using a precise psychophysical procedure, a study further showed that the perception of morphed target expressions was attracted toward the happy emotion of the contextual faces, but not perceived as more fearful when accompanied by an aggressive face, and the happy-induced perceptual bias occurred only in a face-to-face condition that implies social interaction (Gray et al., 2017). In addition, Mumenthaler and Sander (2012) found that social appraisal cues delivered by the gaze of the contextual face amplified the contextual effect in facial emotion recognition, while such influence was independent of the valence of the faces. Taken together, these studies demonstrate that facial emotion perception is systematically shaped by the surrounding expressions, with the strength and direction of these contextual influences varying with experimental tasks and some within-perceiver or within-face factors.

In the contemporary exploration of emotion processing, the role of consciousness is a highly prominent and inevitable topic (Axelrod et al., 2015; Lanfranco et al., 2023a, 2023b, 2024; LeDoux & Brown, 2017; Pessoa, 2005; Qiu et al., 2022; Tamietto & de Gelder, 2010; Vetter et al., 2019; Wang et al., 2023). Extensive evidence on decontextualized faces has demonstrated that some facial expressions can elicit behavioral and neurophysiological responses out of awareness (Axelrod et al., 2015; Faivre, Berthet, & Kouider, 2012; Pournaghdali et al., 2023; Qiu et al., 2022; Vetter et al., 2019; Wang et al., 2023), although some research failed to find evidence for nonconscious emotion processing (Lanfranco et al., 2023a, 2024; Schlossmacher et al., 2017). Notably, Tamietto and de Gelder (2010) had proposed that the nonconscious perception of emotional stimuli may represent an independent phenomenon with potential evolutionary advantages rather than merely a degraded version of conscious perception. This notion was supported by the finding that threat-related facial expressions (i.e., fear) usually receive processing priority over happy or neutral ones under restricted awareness conditions (Mogg & Bradley, 1999; Pournaghdali et al., 2023; Wang et al., 2023; Whalen et al., 1998; Yang et al., 2007), although some studies argue that this prioritization may be driven by low-level stimulus characteristics (Gray et al., 2013; Hedger et al., 2015). The nonconscious processing of threat-related signals may involve partially distinct neural pathways compared with conscious processing (McFadyen et al., 2020; Pessoa & Adolphs, 2010; Tamietto & de Gelder, 2010), with varying modes of brain activation (Jiang & He, 2006; Morris et al., 1998; Tao et al., 2021) and functional connectivity (Morris et al., 1999; Tao et al., 2021; Williams, Das, et al., 2006; Williams, Liddell, et al., 2006). By contrast, happy facial expressions, while also demonstrating some capacity for nonconscious processing (Faivre, Berthet, & Kouider, 2012; Faivre, Charron, et al., 2012), hold an advantage in recognizability and attentional processing mostly in conscious conditions (Calvo & Beltrán, 2013; Wirth & Wentura, 2020). Given the evidence for nonconscious emotion processing and its potential difference from

conscious processing, when revisiting the topic of affective contextual effects, some fundamental questions arise: Can affective contextual modulation occur without conscious awareness? And if so, would consciousness regulate the contextual effects of different emotions (e.g., fearful and happy) in distinct manners?

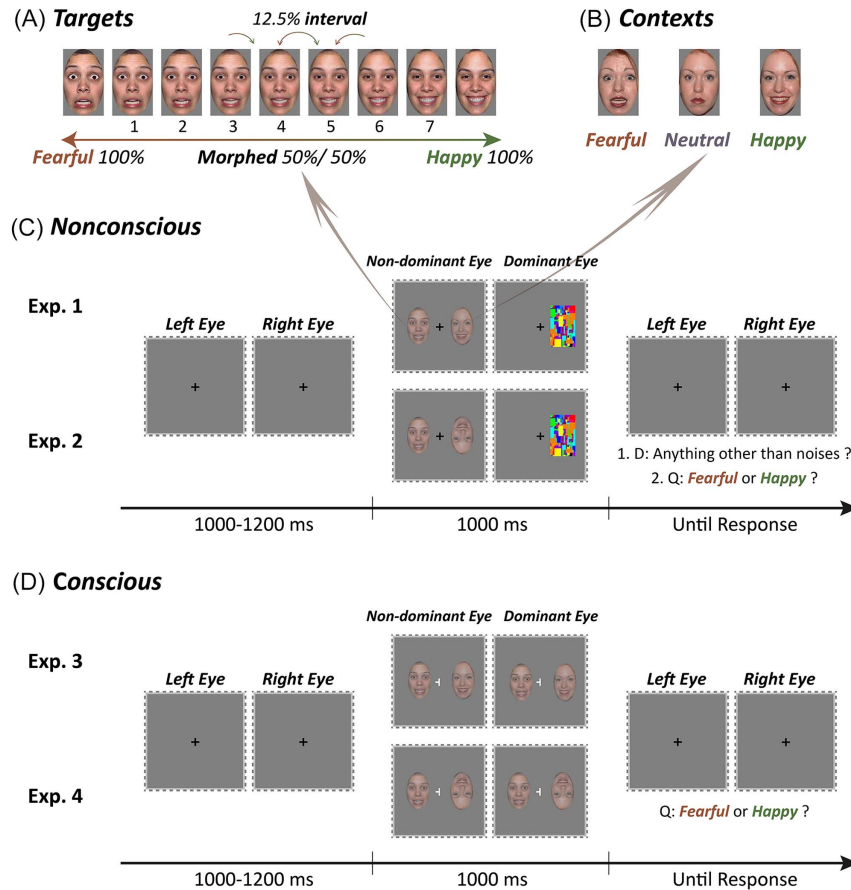
In the present study, we systematically investigated these issues in five experiments. We employed visible and visually suppressed faces with fearful, happy, and neutral expressions as contextual cues, examining their influence on the perception of emotionally ambiguous target faces by psychophysical procedures (Figure 1). Using a similar approach, our previous study has demonstrated that conscious and nonconscious facial contexts differently biased facial emotion perception in social interaction scenes, that is, when a contextual face was socially bonded with a target face through averted gaze cues (Y. Chen et al., 2022). Here, we further explored whether and how affective information from nonconscious contextual faces would bias the interpretation of target facial emotions when lacking explicit social interaction cues. In Experiment 1, we presented a visually suppressed contextual face along with the target face to see if this was sufficient to elicit a perceptual bias toward fearful or happy contextual cues. To rule out the potential effect elicited by low-level features of contexts, we designed Experiment 2 as a control experiment by presenting the contextual faces upside down. Experiments 3 and 4 followed the same design as Experiments 1 and 2, respectively, except for employing visible facial contexts that could be consciously perceived. By contrasting the results with those from the first two experiments, we aimed to delineate whether affective contextual effects induced by faces of varying emotional valence depend on the levels of consciousness. Experiment 5 is an adapted version of Experiment 3, using different stimulus sets to assess the generalizability and robustness of the findings.

Method

Participants

We recruited a total of 160 healthy Chinese college students ($M_{\text{age}} \pm SD = 21.87 \pm 2.38$ years, 61 males) in five experiments, 32 for each experiment (the number of males was 11 in Experiment 1, 10 in Experiment 2, 11 in Experiment 3, 15 in Experiment 4, and 14 in Experiment 5). All participants had normal or correct-to-normal vision and were naïve to the purpose of this study. The experimental procedures were approved by the institutional review board of the Institute of Psychology, Chinese Academy of Sciences (H21041). All participants had signed informed consent and received payments after participation. Data were collected in 2017–2025. The sample size was determined based on a prior power analysis using the G*Power, Version 3.1.9.7 (Faul et al., 2007), in a within-factors repeated measures analysis of variance (ANOVA). Comparable research adopting psychophysical methods has reported a large effect size ($\eta_p^2 = .14$, corresponding to Cohen's $f = 0.40$; Cohen, 1988) for affective contextual effects at the conscious level (Gray et al., 2017). However, as the present study investigates the affective contextual effects at both conscious and nonconscious levels, we adopted a conservative approach by selecting a medium effect size ($f = 0.25$; Cohen, 1988), considering that nonconscious processing typically yields smaller effects compared with conscious processing (W. J. Adams et al., 2010; Pournaghdali et al., 2023). Our calculations indicated that a minimum sample size of 28 participants would be

Figure 1
Sample Stimuli and Example Trials in the Nonconscious (Experiments 1 and 2) and the Conscious (Experiments 3 and 4) Experiments



Note. (A) Target faces. A 100% fearful face and a 100% happy face of the same identity were chosen as endpoints of the sequence. Seven morphed faces (numbered from 1 to 7), showing a linear change from fear to happiness at a step of 12.5%, were selected as the targets. (B) Contextual faces. Emotional faces with three different valences were used as fearful, neutral, and happy contexts. (C) Schematic trials in the nonconscious experiments. In Experiment 1, a contextual face (with a contrast of 0.5) alongside a target face (with a contrast of 0.3 or 0.5) was presented to the nondominant eye for 1,000 ms, and it was masked by full-contrast dynamic noises that flashed at 10 Hz in the dominant eye. In Experiment 2, the contextual face was inverted. After the 1,000-ms stimulus presentation, participants first performed a detection task indicating whether they saw anything in the dynamic noises and then answered an emotion-discrimination question about whether the target face was fearful or happy. (D) Schematic trials in the conscious experiments. In Experiments 3 and 4, the same context and target were presented binocularly as in Experiments 1 and 2, although there were no dynamic noises. Participants performed an emotion discrimination task same as that in the first two experiments. Facial images used in figure are adapted with permission from the NimStim databases (Tottenham et al., 2009), model number 1 and 3. D = detection; Q = question. See the online article for the color version of this figure.

required to detect a medium effect ($\alpha = .05$, statistical power = 0.8). To enhance sensitivity to potential dissociations between conscious and nonconscious mechanisms, we increased the sample size to 32 participants per experiment.

Stimuli and Apparatus

In Experiments 1–4, a total of 32 face stimuli were taken from the NimStim face stimulus set (Tottenham et al., 2009). We cropped out

hairs and nonfacial features outside the face, leaving only a central oval facial area. To ensure ecological validity, color information was retained, as chromatic cues are crucial in real-world face perception (Benitez-Quiroz et al., 2018; Bindemann & Burton, 2009; Yip & Sinha, 2002). To control for potential color-driven confounds while preserving this ecological advantage, we matched the luminance, saturation, and contrast of each facial area using the advanced color match command in Photoshop software (Version 6.10). Specifically, all stimuli from different categories were matched to a single source

image, with the image statistics of this source applied uniformly to all other stimuli. After these manipulations, we picked out eight faces, half happy and half fearful from the same four identities (half males), to generate target stimuli. We first created a sequence of “morphed” faces between the 100% fearful face and the 100% happy face of the same identity, with a linear step of 12.5% (Abrosoft 12 FantaMorph software, Version 5.0). The middle seven “morphed” faces (labeled numbers 1–7), from 12.5% fearful–87.5% happy to 87.5% fearful–12.5% happy, were set as the targets (Figure 1A). From the same manipulated stimulus set, we selected another 24 faces with fearful, neutral, or happy expressions from eight distinct identities (half males) as contextual stimuli (Figure 1B).

In Experiment 5, we used a new set of facial stimuli with high recognizability of the emotions. Specifically, we conducted an additional rating experiment by recruiting a new group of participants (see Supplemental Information for details) to assess the recognizability of fearful, neutral, and happy faces from the NimStim databases. Based on this rating, we selected the facial images of 10 identities (gender balanced) with the highest recognizability of fearful expressions as stimuli. The contextual stimuli consisted of six individual identities with happy, neutral, or fearful expressions, resulting in 18 images in total. The target faces were generated from images of the rest four identities, using the same method as in Experiments 1–4. Notably, the contextual faces used in Experiment 5 were completely different from those used in Experiments 1–4. Additionally, two of the original faces used to generate the target faces were replaced, while the other two remained the same as in the previous experiments. The specific identities of the stimuli are provided in the Supplemental Information.

Visual stimuli were created and displayed using MATLAB (MathWorks, Natick, MA, United States) with the Psychtoolbox extensions (Brainard, 1997), on a monitor with a refresh rate of 60 Hz and a spatial resolution of $1,280 \times 1,024$ pixels. Participants positioned their heads on a chinrest at a viewing distance of about 60 cm and viewed the screen with stereoscopes, which projected the stimuli into their left and right eyes separately.

Procedure

Nonconscious Experiments

In Experiment 1 (Figure 1C), each trial started with a black fixation cross ($0.45^\circ \times 0.45^\circ$) presented at the center of each fusion frame. The fixation remained on the screen until the trial ended. We instructed participants to focus on it throughout the experiment. After 1,000–1,200 ms, visual stimuli were displayed dichoptically to the two eyes using stereoscopes. The stimuli were displayed within two square frames ($9.97^\circ \times 9.97^\circ$), one on the left side and the other on the right side of the screen, to facilitate binocular fusion. In the nondominant eye, the target face ($1.12^\circ \times 1.85^\circ$, at a contrast of 0.3 or 0.5) and contextual face ($1.12^\circ \times 1.85^\circ$, at a contrast of 0.5) appeared on each side of the fixation cross for 1,000 ms. Meanwhile, in the dominant eye, a pattern of full-contrast dynamic Mondrian patterns ($1.23^\circ \times 2.03^\circ$) randomly changed at a rate of 10 Hz on the corresponding location of the contextual face for 1,000 ms, suppressing the contextual faces from visual awareness through the continuous flash suppression (CFS) paradigm (Tsuchiya & Koch, 2005). At the perception level, participants would only perceive an emotionally ambiguous face alongside a chromatic noise pattern for 1,000 ms.

After the stimulus disappeared, participants were required to press the up arrow key if they detected anything in the noise other than the simple dynamic Mondrian patterns in the prior 1,000 ms, which helped identify whether the contextual information was successfully suppressed from awareness. On trials wherein contextual faces were detected, responses to target faces were omitted from further analysis. After that, participants performed a two-alternative forced-choice (2AFC) task to indicate the perceived emotion valence (fearful or happy) of the target face by pressing the left or right arrow key. The key assignments corresponding to fearful and happy responses were counterbalanced across participants. The trial ended after the response of the participants. The experiments comprised 504 trials in random order, with 24 repetitions of three contextual conditions (fearful, neutral, and happy) at seven target morphed levels. Experiment 2 served as a control experiment for Experiment 1, in which we placed the contextual images upside down (Figure 1C) to disrupt high-level face processing and kept the low-level features of the faces intact. Apart from that, everything else in Experiment 2 was the same as in Experiment 1.

Conscious Experiments

Experiment 3 followed the same procedure as in Experiment 1, with three exceptions (Figure 1D). First, the context was not suppressed by the dynamic mask, so the contextual face was visible, and participants could perceive both the target and the contextual faces for 1,000 ms. Second, to indicate which face was the target, we substituted a white T-shaped pointer (rotate $\pm 90^\circ$) for the black fixation cross, with the horizontal line pointing to the target face, during stimulus presentation. Third, participants performed only the emotional discrimination task. Experiment 4 served as a control experiment for Experiment 3. It had the same procedure as that for Experiment 3, except that the contextual face was inverted (Figure 1D). Experiment 5 adopted the same procedure as Experiment 3 but used a different set of stimuli, aiming to test the robustness and universality of the observed effects.

Data Analysis

We first excluded the trials wherein the contextual face broke through suppression in the nonconscious experiments. Then for each participant under each contextual condition (fearful, neutral, or happy), we calculated the proportion of “happy” responses at seven target morphed levels and fitted them with the Boltzmann sigmoid function, $f(x) = 1/(1 + \exp((x - x_0)/\omega))$. From the psychophysical curves, we took the point of subjective equality (PSE) and different limen (DL) as the dependent variables and compared them among conditions. PSE indicates the point at which participants perceive the target emotion as equally happy and fearful. The PSE shifts among different contextual conditions indicate the influence of contextual face emotions on target emotion discrimination. If the PSE in a happy context is smaller than neutral, it indicates a bias to perceive the target face as happier in happy than in neutral contexts. By contrast, if the fearful context produces a larger PSE versus neutral, it reflects a bias toward more fear perception in fearful contexts. DL (half the interquartile range of the fitted function) is the index showing participants’ sensitivity to discriminate targets in each contextual condition. The smaller the DL, the higher the sensitivity.

Transparency and Openness

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. All data and analysis code are publicly available on the knowledge repository of the Institute of Psychology, Chinese Academy of Sciences, at <https://ir.psych.ac.cn/handle/311026/47455> (Y. Chen et al., 2025). Data were analyzed using JASP, Version 0.18.1.0. This study's design and its analysis were not preregistered.

Results

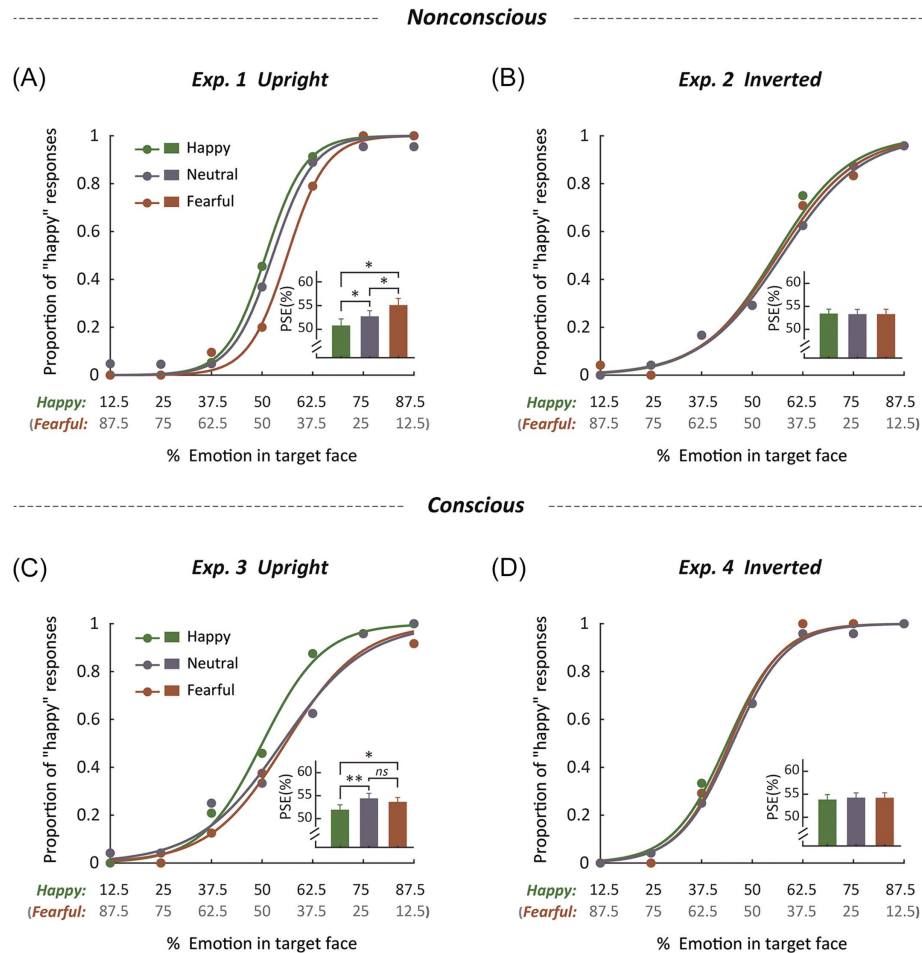
Experiments 1 and 2: Nonconscious Context

In Experiment 1, 2.68% of trials ($M = 13.50$, $SD = 27.94$), where context faces were incompletely suppressed, were excluded before

statistical analyses. Exclusions for each condition were as follows: happy ($M = 3.78$, $SD = 8.11$), fearful ($M = 5.09$, $SD = 10.70$), and neutral ($M = 4.63$, $SD = 9.42$). A one-way ANOVA on the remaining trials yielded a significant main effect of contextual conditions for PSE (Figure 2A; $F(2, 62) = 7.334$, $p = .001$, $\eta_p^2 = .191$). Subsequent comparisons with Holm–Bonferroni correction (Holm, 1979) showed that the values of PSE between the visually suppressed happy and fearful context conditions differed significantly, $t(31) = -2.833$, $p = .024$, Cohen's $d = 0.501$, 95% CI for the mean difference $[-8.404, -0.473]$, indicating that the emotional valence of the contexts affects emotion perception. Moreover, relative to the neutral context condition, there was an increase of PSE in the fearful context condition, $t(31) = 2.833$, $p = .024$, Cohen's $d = 0.501$, 95% CI for the mean difference $[0.262, 4.650]$, and a decrease of PSE in the happy context condition, $t(31) = -2.166$, $p = .038$, Cohen's $d = 0.383$, 95% CI for

Figure 2

Psychometric Curves of Typical Observers and the Group Point of Subjective Equality Results for Experiments 1–4



Note. Fearful or happy contexts biased emotional judgment relative to neutral contexts, which are reflected by the shift of PSEs among these conditions in nonconscious (A, upright; B, inverted) and conscious (C, upright; D, inverted) contexts. Error bars show standard errors of the mean. PSE = point of subjective equality; *ns* = nonsignificant; Exp. = Experiment. See the online article for the color version of this figure.

* $p < .05$. ** $p < .01$.

the mean difference $[-4.299, 0.334]$. These results indicated that the perceived target expression was biased toward the valence of the contextual images. In other words, participants were largely biased toward perceiving the target as more fearful in the fearful context, whereas happier in the happy context, as compared with in the neutral context, even when the contexts were visually suppressed. This nonconscious affective contextual effect could not be due to the difference in the discrimination sensitivity, as the same analysis conducted on the DL revealed no significant difference among the three emotional contextual conditions, $F(2, 62) = 1.193, p = .310, \eta_p^2 = .037$, Bayes factor $(BF)_{01} = 4.140$.

To rule out the potential impact of low-level visual features on the effect observed with upright presented emotional contextual faces, we presented the contextual stimuli upside down in Experiment 2. The percentage of excluded trials was 0.58% ($M = 2.94, SD = 6.97$). Exclusions for each condition were as follows: happy ($M = 1.13, SD = 2.47$), fearful ($M = 0.84, SD = 2.26$), and neutral ($M = 0.97, SD = 3.04$). The significant main effect of contextual conditions for PSE observed in Experiment 1 disappeared when the contexts were inverted (Figure 2B; $F(2, 62) = 0.037, p = .964, \eta_p^2 = .001, BF_{01} = 10.255$), indicating that the emotional information rather than low-level features of the contextual face determined the nonconscious affective contextual effect. Meanwhile, no significant difference in DL among the three emotional contextual conditions was evident, $F(2, 62) = 1.042, p = .359, \eta_p^2 = .033, BF_{01} = 4.684$.

Experiments 3 and 4: Conscious Context

To investigate if there was a dissociation of affective contextual effects between the conscious and nonconscious contexts, we further conducted two experiments in which the contextual faces were rendered visible. In these conscious experiments, we conducted the same analysis as in the nonconscious experiments.

A one-way ANOVA revealed a significant main effect for PSE of visible contextual conditions in Experiment 3 (Figure 2C; $F(2, 62) = 8.996, p < .001, \eta_p^2 = .225$). Similar to the nonconscious experiment, there was a significant difference between the visible happy and fearful contextual conditions, $t(31) = -2.481, p = .037$, Cohen's $d = 0.439$, 95% CI for the mean difference $[-3.449, 0.034]$. Specifically, the visible happy contexts increased the happy perception of targets as compared with the neutral contexts, $t(31) = -5.126, p < .001$, Cohen's $d = 0.906$, 95% CI for the mean difference $[-3.688, -1.250]$. However, there was no evident influence of fearful context on emotional judgment compared with the neutral contexts, $t(31) = -1.268, p = .214$, Cohen's $d = 0.224$, 95% CI for the mean difference $[-2.282, 0.758]$, which is in contrast to the significant fear-induced contextual effect in the nonconscious experiment. Additionally, these results appeared to be unaffected by participants' sensitivities as the values of DL were not different among the three emotional contextual conditions, $F(2, 62) = 2.355, p = .103, \eta_p^2 = .071, BF_{01} = 1.715$.

In Experiment 4, as in Experiment 2, the contextual stimuli were also presented upside down to control for the effect resulting from low-level visual processing. One-way ANOVA yielded no significant differences for PSE (Figure 2D), $F(2, 62) = 0.452, p = .639, \eta_p^2 = .014, BF_{01} = 7.376$, and DL, $F(2, 62) = 0.055, p = .947, \eta_p^2 = .002, BF_{01} = 8.510$, among the three different emotional contextual conditions. These results illustrated that the affective contextual effect observed in conscious contexts was not likely induced by low-level visual features of the contextual face.

Comparisons of the Nonconscious and the Conscious Affective Contextual Effects

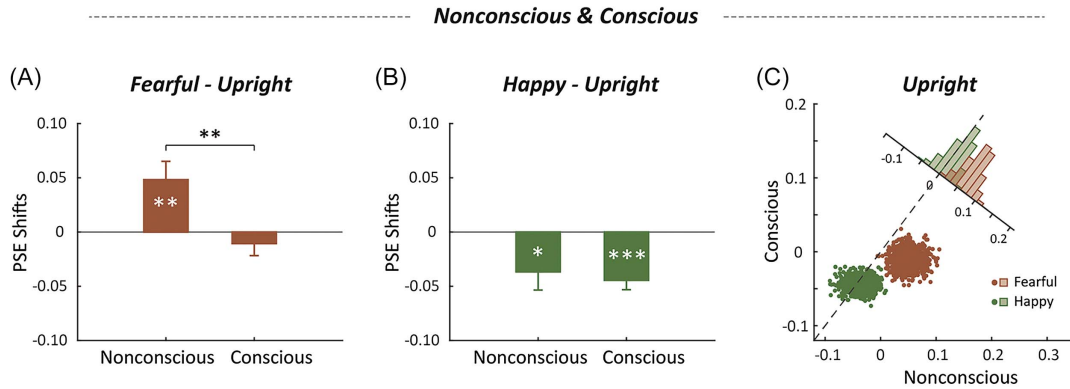
We further compared the results from Experiments 1 and 3 to address the role of consciousness in the affective contextual effect under different emotional valences. To facilitate comparison, we first obtained the normalized PSE shift values for the happy and fearful context conditions from the neutral context condition for each individual in each experiment, as $(PSE_{\text{happy or fearful}} - PSE_{\text{neutral}})/PSE_{\text{neutral}}$. This index indicates the magnitude of the affective contextual effect, adjusted for individual differences in emotion perception under the neutral context condition. One-sample t tests revealed that the visually suppressed fearful context biased participants toward perceiving the morphed target as more fearful, resulting in a positive PSE shift from 0, $t(31) = 2.842, p = .008$, Cohen's $d = 0.502$, 95% CI for the mean difference $[0.014, 0.083]$, whereas the visible fearful context did not, $t(31) = -0.948, p = .350$, Cohen's $d = 0.168$, 95% CI for the mean difference $[-0.033, 0.012]$. More importantly, an independent-samples t test showed that the PSE shifts for fearful context differed significantly between the two consciousness levels (Figure 3A; $t(62) = 2.895, p = .005$, Cohen's $d = 0.724$, 95% CI for the mean difference $[0.018, 0.099]$). By contrast, both the visually suppressed and visible happy context shifted the PSE to the happy side, reflecting a bias to perceive the target face as happier—visually suppressed: $t(31) = -2.195, p = .036$, Cohen's $d = 0.388$, 95% CI for the mean difference $[-0.071, -0.003]$; visible: $t(31) = -5.166, p < .001$, Cohen's $d = 0.913$, 95% CI for the mean difference $[-0.062, -0.027]$ —and the effects were comparable between the two consciousness levels (Figure 3B), $t(46) = 0.413, p = .681$, Cohen's $d = 0.103$, 95% CI for the mean difference $[-0.030, 0.045]$. To better illustrate the results, we generated 1,000 bootstrap samples from the original data set to estimate the distribution for PSE shifts in fearful and happy contextual conditions across different levels of consciousness, respectively. As shown in Figure 3C, the bootstrapped sample mean points of the happy emotional context fell mostly on the diagonal with a slope of 1, while the points in the fearful context fell mostly below the diagonal. Together, these results show a clear dissociation of the fear-related contextual effect between the nonconscious and conscious conditions, while the effect of happy contexts occurred independently of the conscious level.

Experiment 5: Replication Experiment in Conscious Condition

While both fearful and happy contextual effects were observed under nonconscious conditions (Experiment 1), only the happy effect occurred under conscious conditions (Experiment 3). To further evaluate the stability and reproducibility of this happy-specific affective contextual effect in conscious conditions, we conducted an additional replication experiment (Experiment 5). Specifically, in Experiment 5, we replaced the sample of stimuli used in previous experiments to determine whether the effect was driven by idiosyncrasies in the particular stimuli set employed or if it can be replicated with different sets of faces. Additionally, considering that happy expressions are usually more accurately identified than fearful expressions (Tottenham et al., 2009; Wells et al., 2016), we selected contextual faces with the highest recognizability (particularly for fearful expressions) to minimize potential confounds arising from differential recognition accuracies (see Supplemental Information

Figure 3

Dissociations of the Affective Contextual Effects Induced by Upright Faces Between the Nonconscious (Experiment 1) and the Conscious (Experiment 3) Experiments



Note. The affective contextual effect was measured by PSE shifts in (A) the fearful context condition and (B) the happy context condition, with the individual PSE in the neutral condition serving as the reference. Error bars show standard errors of the mean. (C) Bivariate distributions of 1,000 bootstrapped sample means. PSE = point of subjective equality. See the online article for the color version of this figure.

* $p < .05$. ** $p < .01$. *** $p < .001$.

for details). The same analysis was conducted as in the previous experiments.

Experiment 5 yielded consistent results with those of Experiment 3. One-way ANOVA yielded a significant effect for PSE among the three affective contexts, $F(2, 62) = 17.923$, $p < .001$, $\eta_p^2 = .366$. As illustrated in Figure 4, compared with neutral contexts, the happy context biased the emotion perception of target, $t(31) = -5.297$, $p < .001$, Cohen's $d = 0.440$, 95% CI for the mean difference $[-3.625, -1.325]$, whereas the fearful context did not, $t(31) = -0.232$, $p = .817$, Cohen's $d = 0.019$, 95% CI for the mean difference $[-1.258, 1.041]$. Additionally, a significant difference was also observed between happy and fearful contexts, $t(31) = -5.065$, $p < .001$, Cohen's $d = 0.421$, 95% CI for the mean difference $[-3.516, -1.217]$. For DL, no statistically significant difference among the three contexts was evident, $F(2, 62) = 2.644$, $p = .079$, $\eta_p^2 = .079$, $BF_{01} = 1.327$. These results verify the findings of Experiment 3, suggesting that happy-specific affective contextual effects are robust and reproducible under conscious conditions.

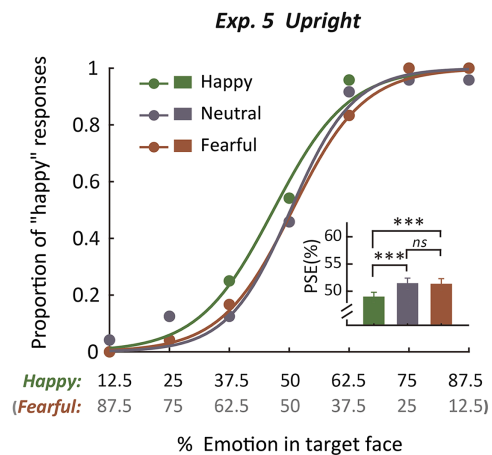
Discussion

Facial expressions in real life are generally ambiguous and highly contextualized (Aviezer et al., 2017; Barrett et al., 2011; Y. Chen et al., 2022; Hadders-Algra, 2022; Hassin et al., 2013; Wieser & Brosch, 2012). Emerging evidence highlights the importance of the faces of other individuals in facial emotion contextualization, albeit with some noted inconsistencies and potential restrictions regarding how facial context modulates the perceived emotion of the target face (Gray et al., 2017; Mumenthaler & Sander, 2012; Russell & Fehr, 1987; Schulte Holthausen et al., 2016). In the present study, to deepen the comprehension of the constraints and underlying mechanisms through which facial context affects emotion perception, we extended the line of inquiry by manipulating the visibility and emotional valence of the facial context. Using an emotion

categorization task, a previous study found that a visually suppressed contextual face with congruent emotion facilitated the recognition of diagnostic expressions on a target face (Ye et al., 2014). However, the paradigm used could not answer whether nonconscious affective context biased target emotion perception, and it was also unclear whether the observed effect was attributed to the congruency between the image properties or stemmed from emotion information integration. Therefore, here we adopted a psychophysical procedure that allows for a more direct and sensitive

Figure 4

Psychometric Curves of a Typical Observer and the Group Point of Subjective Equality Results for Experiment 5



Note. Happy but not fearful context-biased target emotion perception relative to neutral context. Error bars show standard errors of the mean. PSE = point of subjective equality; *ns* = nonsignificant. See the online article for the color version of this figure.

*** $p < .001$.

measurement to quantify the perceptual influence induced by emotional context, with additional experiments to control for the potential impact of physical image properties. We found that both visible and visually suppressed facial contexts could bias the perception of the visible target face toward the contextual emotion (Experiments 1, 3, and 5). Moreover, the control experiments (Experiments 2 and 4) showed that an inverted context could not induce the contextual effects, excluding the role of low-level image properties in the observed effects. These findings suggest that nonconscious affective context can induce a perceptual shift resulting from emotion integration, supporting the view of automatic integration of emotional contexts into facial emotion perception (Mumenthaler & Sander, 2012).

More crucially, we found that facial contexts with happy and fearful emotional valences elicit distinct contextual effects at different conscious levels, underlining the intertwined impact of context visibility and facial expression. For visible context featuring happy expressions, the perceived target emotion was biased toward happiness, which is broadly in line with the findings from earlier studies supporting the attraction effect (Fenske & Eastwood, 2003; Gray et al., 2017; Schulte Holthausen et al., 2016). Furthermore, the attraction effects induced by happy contexts were immune to awareness manipulation, although the effect size of the nonconscious happy-induced contextual effect was slightly weaker than that of fearful contexts. This result is compatible with the observations that when facial expressions are not accessible to conscious awareness, the prominence of a happy face is still evident compared with expressions of lower arousal levels, i.e., neutral or sad (Faivre, Charron, et al., 2012; Juruena et al., 2010; Killgore & Yurgelun-Todd, 2004). From an evolutionary perspective, the prevalence of the happy-induced contextual effect may arise from the significance of happy facial expressions in social life, as happy faces generally indicate friendly social interaction that conveys possible benefits (Mehu & Dunbar, 2008; Mehu et al., 2007). However, note that the contextual effect in nonconscious happy contexts has not been observed in a previous study employing target faces with joint social cues, that is, averted gaze (Y. Chen et al., 2022). One possible explanation is that the averted gaze of the target face may induce a bias toward fear (R. B. Adams & Kleck, 2003), ultimately diminishing the magnitude of the influence exerted by the happy contextual cues. This discrepancy implies that the integration of emotional signals with and without social cues may engage different mechanisms, underscoring the complexity of emotional information integration.

In contrast to the pervasive influence of happy contexts, there was an apparent dissociation between the conscious and nonconscious contextual effects induced by fearful contexts. Specifically, emotional perception of the morphed ambiguous target face shifted toward more fearful only when accompanied by visually suppressed fearful faces, whereas this effect disappeared when participants were aware of the presence of the contextual face. This intriguing finding is likely to be related to the distinct cognitive and neural mechanisms underlying conscious and nonconscious fear information processing due to the evolutionary implications of threat-related information. Facial expressions of fear, as biologically salient signals of potential danger (Wieser & Keil, 2014), can help survive and cope with danger and are considered to engage the activity of emotion-sensitive areas in both cortical (e.g., prefrontal cortex) and subcortical (e.g., amygdala; Kragel et al., 2021; McFadyen et al., 2020; Morris et al., 1999; Silverstein & Ingvar, 2015; Tamiotto & de Gelder, 2010; Williams, Liddell, et al., 2006) structures. According to the theoretical frameworks of neural integration and consciousness from Tamiotto and de Gelder (2010), the

dissociative effect induced by fearful facial contexts may result from the interaction of cortical and subcortical structures. In response to the consciously perceived fearful contexts, the cortical feedback might have an inhibitory modulation over the subcortical area (Silverstein & Ingvar, 2015) after fine evaluation that the visible contexts were not suggestive of real threats, thereby weakening the role of subcortical pathways (Kragel et al., 2021) in guiding individuals to respond to threat-related information. However, when such fearful contexts were visually suppressed, the subcortical pathway might dominate the processing of threat-related information and trigger automatic coping mechanisms with fear (Méndez-Bértolo et al., 2016; Morris et al., 1999; Öhman et al., 2007; Whalen et al., 1998), thus biasing the perception of the target face toward the visually suppressed fearful context.

Beyond the general evolutionary accounts mentioned above, multiple interacting mechanisms may also contribute to the observed asymmetry of happy and fearful contextual effects across different awareness levels. One possible explanation involves the valence-dependent modulation of attentional scope (Fenske & Eastwood, 2003; Fox et al., 2001), that is, positive valence broadens the spatial scope of visual attention, while negative valence narrows focus toward central salient cues. Building upon this framework, the visible happy contexts may facilitate target-context integration by expanding the attentional scope, thereby enhancing contextual modulation. By contrast, fearful contexts may lead to attentional narrowing, which prioritizes threat appraisal over contextual processing. Additionally, the differential perceptual salience of emotional expressions may play a role (Calvo & Nummenmaa, 2008). Recognition accuracy for happy faces can reach a ceiling (see Supplemental Information) due to their higher familiarity and less ambiguous features (Calvo & Nummenmaa, 2016), resulting in higher recognizability than fearful faces. These factors likely combine to amplify the stronger facilitative effects of happy contexts while limiting the contextual influence of negative expressions in conscious conditions. Besides, potential differences in the inherent characteristics of different expressions, such as spatial frequency (SF), also warrant consideration. As facial emotion perception of different expressions may rely on different SFs (e.g., see conflicting evidence regarding low SF vs. high SF biases in fearful expression recognition; Holmes et al., 2005; Pourtois et al., 2005; Smith & Merlusca, 2014; Stein et al., 2014; Vuilleumier et al., 2003), manipulating SF components in future studies might provide deeper mechanistic insights into the current findings.

In the present study, we employed the CFS paradigm to ensure robust suppression of emotional faces. CFS offers superior suppression duration and stability compared with backward masking or binocular rivalry, making it ideal for investigating sustained nonconscious processing (Lanfranco et al., 2023b; Tsuchiya & Koch, 2005; Tsuchiya et al., 2006). To assess suppression efficacy, we implemented trial-by-trial subjective reports, which are considered to have face validity by directly evaluating the subjective experience of conscious perception (Lau, 2008). However, because subjective reports are inherently susceptible to individual differences in response criteria (Lanfranco et al., 2023b; Pournaghdali & Schwartz, 2020), future investigation could implement bias-free approaches, such as the detection–discrimination dissociation paradigm (Stein & Peelen, 2021) and model-based analyses (Pournaghdali et al., 2023), to control for criterion variability while enabling quantification of awareness. It is noteworthy that in the present study, the impact of response bias on nonconscious perception appears relatively limited. Specifically, the

distinct patterns of affective contextual effects between conscious and unconscious conditions indicate that the nonconscious results were not driven by partial awareness (i.e., residual consciousness) but rather by unique mechanisms independent of conscious perception.

The current findings provide novel evidence for nonconscious emotional processing by demonstrating that sustained suppression of upright (but not inverted) emotional faces systematically biases conscious target judgments under CFS, implicating high-level emotion integration rather than low-level feature confounds. In line with this, Vetter et al. (2019) demonstrated that CFS-suppressed emotional faces can guide eye movements, with an inversion effect further supporting that high-level facial expression processing survives under nonconscious conditions. However, some detection-based studies, such as those employing b-CFS, attributed nonconscious processing advantages of fearful faces versus others to low-level confounds (Gray et al., 2013; Hedger et al., 2015) or reported no emotion-specific enhancements in detection sensitivity (Lanfranco et al., 2023a). A recent work employing ultra-brief unmasked exposures further revealed that awareness emerges synchronously with stimulation detection, while emotion discrimination requires longer exposure durations, arguing that awareness is a prerequisite for emotional content processing (Lanfranco et al., 2024). The observed discrepancies likely arise from differences in task demands. In priority detection tasks, low-level features dominate the process, while in tasks assessing indirect behavioral impacts (e.g., perceptual bias, oculomotor guidance), high-level emotional processing can still occur without conscious awareness. However, it is worth noting that even with detection tasks, some research still found evidence for nonconscious facial expression recognition when adopting a model-based analysis for awareness assessment (Pournaghdali & Schwartz, 2020; Pournaghdali et al., 2023). Besides these methodological factors, the manipulation of experimental stimuli might also influence the results. For example, Schlossmacher et al. (2017) observed no emotion-specific effects under CFS, potentially linked to the reduced facial contrast, which enhanced suppression but might have diminished stimulus salience below functional thresholds. Future research needs to carefully consider experimental design and configurations to elucidate the mechanism underlying nonconscious facial expression processing.

Constraints on Generality

The current findings are primarily based on gender-balanced healthy Asian college students, and external validity may be limited when generalized outside of this specific population due to documented differences in affective contextual effect across cultural backgrounds (e.g., Eastern vs. Western; Ko et al., 2011; Masuda et al., 2008), age groups (e.g., younger vs. older adults; Ngo & Isaacowitz, 2015; Noh & Isaacowitz, 2013), and clinical populations (e.g., brain disorders; Aviezer et al., 2009, 2012; Kumfor et al., 2018). In addition, individual characteristics, such as trait anxiety (Y. Chen et al., 2022), which have been demonstrated to influence gaze-mediated affective contextual effects at the nonconscious level, require further consideration in future studies.

Conclusion

In summary, our study delineated an attractive contextual effect in facial emotion perception induced by another emotional face without other social cues, contingent on the visibility and emotional valence of

the contexts. While fearful contexts biased perception only in the visually suppressed condition, the effect of happy contexts occurred independent of the awareness manipulation. These findings extend the affective contextual effect to the nonconscious level. More importantly, they highlight the interplay of consciousness and stimulus valence in emotion information integration, advancing our understanding of the constraints and mechanisms by which affective context molds facial emotion perception.

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Received August 19, 2024

Revision received February 28, 2025

Accepted July 23, 2025 ■

Erratum to “Affective Control in Adolescence: The Influence of Age and Depressive Symptomatology on Working Memory” by Griffiths et al. (2025)

The article “Affective Control in Adolescence: The Influence of Age and Depressive Symptomatology on Working Memory,” by Kirsty Griffiths, Darren L. Dunning, Jenna Parker, Marc Bennett, Susanne Schweizer, Lucy Foulkes, Saz Ahmed, Jovita T. Leung, Cait Griffin, Ashok Sakhardande, Willem Kuyken, J. Mark G. Williams, Sarah-Jayne Blakemore, Tim Dalgleish, Jason Stretton, and the MYRIAD Team (*Emotion*, 2025, Vol. 25, No. 1, pp. 70–78, <https://doi.org/10.1037/emo0001390>), had the incorrect open access license listed in the author note due to a processing error. The correct open access license for the article is CC BY 4.0; <https://creativecommons.org/licenses/by/4.0>. The online version of this article has been corrected.

<https://doi.org/10.1037/emo0001596>