Disgust exposure and explicit emotional appraisal enhance the LPP in response to disgusted facial expressions

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Abstract

The influence of prior exposure to disgusting imagery and the conscious appraisal of facial expressions were examined in an event related potential (ERP) experiment. Participants were exposed to either a disgust or a control manipulation and then presented with emotional and neutral expressions. An assessment of the gender of the face was required during half the blocks and an affective assessment of the emotion in the other half. The emotion-related EPN and LPP ERP components were examined for disgust and neutral stimuli. Results indicated that the EPN was enhanced for disgusted over neutral expressions. Prior disgust exposure modulated the middle phase of the LPP in response to disgusted but not neutral expressions, but only when the emotion of the face was explicitly evaluated. The late LPP was enhanced independently of stimuli when an emotional decision was made. Results demonstrated that exposure to disgusting imagery can affect the subsequent processing of disgusted facial expressions when the emotion is under conscious appraisal.

Keywords: Disgust, LPP, ERPs, decisions, context

Introduction

The cognitive processing of emotional facial expressions is a vital component of human social interaction that facilitates the ability to determine the state of mind of others very quickly. The importance of facial expressions in the visual system has been highlighted in research suggesting that emotional expressions have priority over non-emotional expressions in capturing attention (Calder & Young, 2005; Eimer & Holmes, 2007; Fox, Russo, Bowles, & Dutton, 2001; Tsao & Livingstone, 2008; Vuilleumier & Pourtois, 2007), and can do so even when attention is diverted to another task (Eastwood, Smilek, & Merikle, 2003; Öhman, Flykt, & Esteves, 2001). The capacity for emotional expressions to capture attention is well established, but less is known about the contextual factors that can influence this processing. This is important as variability in an individual's mood and psychological state may have the potential to accentuate this emotion detection mechanism, and the ability to do so may confer an adaptive advantage, priming the individual to detect social signals more readily. Research into emotional adaptation has highlighted the impact of exposure to a particular expression on the subsequent interpretation of a target facial expression (Pell & Richards, 2011, 2013; Skinner & Benton, 2010). There is also growing evidence from Electroencephalography (EEG) research that emotional contextual factors such as question framing (Kisley et al., 2011; Rehmert & Kisley, 2013), directed emotional attention (Ferrari, Codispoti, Cardinale, & Bradley, 2008) and negative audio descriptions of the stimuli (Foti & Hajcak, 2008) can affect the processing of emotionally evocative scene images. The present study explores the ways in which exposure to a particular emotion can affect the processing of specific emotional expressions.

Given the high temporal resolution, and the ability to examine processing while it occurs, EEG methods have been utilised increasingly to study the processing of emotional stimuli of all types and the factors that impact this processing. Early emotional effects are reliably observed in the early posterior negativity (EPN) event related potential (ERP) component, which is characterised by an enhanced occipito-temporal negativity for emotionally arousing stimuli from approximately 150-300 ms post-stimulus onset (Junghöfer, Bradley, Elbert, & Lang, 2001; Schupp, Junghöfer, Weike, & Hamm, 2003), and is enhanced for emotional compared to neutral facial expressions (Balconi & Pozzoli, 2003; Foti, Hajcak, & Dien, 2009). There is also some evidence that the component is sensitive to valence and is enhanced for angry facial expressions compared to happy or neutral (Schupp, Junghöfer, Weike, & Hamm, 2004), likely reflecting the tagging of emotionally salient stimuli for further processing (Schupp, Öhman et al., 2004; Schupp, Stockburger et al., 2006) independent of threat associations (Bublatzky & Schupp, 2010).

Emotional effects are also reliably found in the form of an enhanced positivity across centro-parietal regions. These effects have been known to manifest in the form of an early positivity (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Kiss & Eimer, 2008; MacNamara, Foti, & Hajcak, 2009), though they are often observed in the subsequent sustained late positive potential (LPP) ERP waveform (Brown, van Steenbergen, Band, de Rover, & Nieuwenhuis, 2012) that is particularly noticeable 400-600 ms post-stimulus onset (Schupp, Flaisch, Stockburger, & Junghöfer, 2006). This sustained positivity is augmented by emotional compared to neutral stimuli (Weinberg & Hajcak, 2010) and appears to be sensitive to emotional arousal (Schupp, Junghöfer, Weike, & Hamm, 2004). Interpretations of LPP data have suggested that the LPP reflects the post-perceptual processing of emotionally salient stimuli and it is thought to be sensitive to top-down influences and explicit interpretation of stimuli (Lee et al., 2010). It has been speculated that the entire length of the LPP represents numerous overlapping components (Foti, Hajcak, & Dien, 2009; Weinberg & Hajcak, 2011) with research suggesting that the earlier phase of the LPP (approximately 400-600 ms post-stimulus onset) reflects the automatic attentional capture of salient information, whereas the later phase (post 600 ms) is more influenced by top-down attentional capture (Olofsson, Nordin, Sequeira, & Polich, 2008; Weinberg & Hajcak, 2011; Weinberg, Hilgard, Bartholow, & Hajcak, 2012) and contextual factors (Foti & Hajcak, 2008; Kisley et al., 2011).

Here we build on the area of contextual effects on emotional processing by investigating whether targeted prior exposure to a specific emotion can exert an influence on the visual processing of a specific emotion. Exposure to one emotion may have the potential to alter receptivity to that emotion and aid subsequent detection of it in the visual environment or to divert extra resources to processing that emotion when it is detected. Much LPP research has been conducted on emotional scenes; however it is difficult to examine differences between specific emotions (rather than between broad valence categories) using these stimuli. Therefore, the current study uses facial expressions in order to target specific emotional categories more effectively. Specifically, we examine whether exposure to disgusting imagery can affect the processing of disgusted facial expressions in an ERP study. Exposure to disgust is of interest as it has been shown to influence explicit moral judgement (Helzer & Pizarro, 2011; Wheatley & Haidt, 2005; Zhong, Strejcek, & Sivanathan, 2010), an effect that may be mediated by body consciousness (Schnall, Haidt, Clore, & Jordan, 2008) and attentional control (van Dillen, van der Wal, & van den Bos, 2012). Individual predisposition towards feeling disgusted is also a predictor of numerous long-term psychological disorders such as OCD (Mancini, Gragnani, & D'Olimpio, 2001; Thorpe, Patel, & Simonds, 2003), anxiety (Muris, Merckelbach, Schmidt, & Tierney, 1999) and phobias (de Jong & Merckelbach, 1998; Sawchuk, Lohr, Tolin, Lee, & Kleinknecht, 2000). Thus, while much research has examined the capacity for disgust exposure to influence behaviour, it is not clear whether more transient emotional processing effects can also manifest. The present study examines whether exposure to disgusting imagery can influence the processing of disgusted facial expressions or emotional expression processing more broadly. If priming individuals to feel disgusted manifests effects in early face processing as well as in later cognitive appraisals and behaviour, then it has important implications for the pervasive nature of the disgust sensation and its ability to influence a multitude of aspects of perception and cognition. This would also illuminate whether specific contextual factors can selectively influence the processing of specific facial expressions.

One potential factor that could mediate the effect of emotional exposure on subsequent emotion processing is conscious emotional appraisal. It is possible that if an individual is engaged with consideration of a non-emotional attribute of a target stimulus, then the influence of prior emotional exposure on the processing of that target stimulus could be inhibited. fMRI research has suggested that although emotion processing can be down-regulated when attention and cognitive resources are focussed on another task (Pessoa, 2005; Pessoa & Ungerleider, 2004; van Dillen, Heslenfeld & Koole, 2009), this does not mean that an explicit emotional appraisal task is necessary to observe emotion related neural activity – as this processing still occurs when emotional expressions are passively viewed (Lange et al., 2003; Zald, 2003). It is likely that such emotional related activation occurs automatically (in cases when there is no competing task to monopolize cognitive resources) but is enhanced further when combined with conscious emotional evaluation (Habel et al., 2007), an effect that is mirrored by ERP research pointing towards a modulation of the LPP (above the standard emotional modulation) as a result of the participant consciously increasing their emotional reaction to an image (Moser, Most, & Simons, 2010). With regard to disgust, there is evidence that explicit emotional rumination following disgust exposure can result in a more pronounced effect on moral judgement (van Dillen et al., 2012) thus emphasising the importance of emotional reflection on subsequent cognition. The present study therefore employs both emotional and non-emotional discrimination tasks to examine whether differences in neural response to emotional stimuli emerge between these tasks following prior emotional exposure.

In sum, in this experiment we investigate whether the processing of specific emotions can be influenced by prior emotional exposure, and whether conscious emotional evaluation is necessary to facilitate this effect. We focus on the modulation of established emotional ERP components (EPN and LPP) for disgusted compared to neutral expressions following this exposure. Our aims are four-fold; firstly, we examine whether exposure to disgusting videos can influence disgusted facial expression processing over exposure to non-emotional videos. Secondly, we examine whether any exposure effects manifest only when participants are engaged in emotional appraisal (in the form of deciding on the emotion of the faces), compared with when they are engaged in appraisal of another aspect of the face (the gender). Thirdly, we examine whether exposure to disgust affects disgusted expression processing specifically, or whether it can also generalise to influence angry or happy expression processing as well. Finally, we examine whether individual differences in disgust sensitivity correlate with effects related to disgust exposure.

Method

Participants

Twenty-nine participants were recruited but six were excluded due to excessive EEG artefacts. This resulted in 23 right-handed participants (27.39, SD = 7.56; 15 males) being retained for the analysis. Ethical approval was granted by the Birkbeck College ethics board in the Department of Psychological Sciences.

Stimuli

A total of 112 stimuli were selected from the NimStim facial expression database (Tottenham et al., 2009) that contained 28 each of angry, disgusted, happy and neutral facial expressions, using an even split of males and females. The same 14 models were used for all facial expressions, with two images from each model used for each emotion (an open and closed mouth version). Images were cropped to exclude hair and converted to grey scale with the average luminance matched. Twenty of each facial expression were used as the stimuli in the experimental blocks and eight in the practice blocks. Images were resized to 253 x 325 pixels and presented against a dark background.

Eight 1 minute videos were adapted from YouTube uploads (with audio removed). The four experimental condition videos contained disgusting imagery (two depicted maggots infesting wounds, one depicted a dog vomiting and the other a surgical operation on a rat), whereas the four videos in the control condition portrayed innocuous scenes not containing any disgusting elements.

Aesthetic elements (such as animals and body parts) were matched between the videos and none contained human faces.

Design and procedure

Participants completed either the experimental (*n* = 12) or control (*n* = 11) conditions. There were 10 experimental blocks, with each block containing 120 trials presented in random order, with 5 blocks requiring a gender decision and the other 5 requiring an affective decision. Participants completed all 5 blocks of one type followed by 5 blocks of the other type, with the starting decision counterbalanced across participants. Each block comprised 20 trials each of angry, disgusted and happy facial expressions along with 60 neutral facial expressions (to balance the number of emotional and non-emotional stimuli). There were two practice blocks of 48 trials (eight each of angry, disgusted and happy along with 24 neutral) that were presented before blocks 1 and 6. The four videos were presented in a randomised order before the first and after the second, fifth and seventh blocks.

Each trial began with a central fixation cross on the screen for 700 ms followed by a facial expression stimulus for 300 ms. Following each stimulus was an interval randomised between 250 and 350 ms. On a random 10% of the trials participants were prompted to make a decision about the face that had just been presented (with instructions before the task informing them either that they would have to decide if the face was emotional or neutral, or if it was male or female) with decisions made via a left or right response key. After block 5, the decision participants were required to make was switched.

Following the trials, participants categorised the emotion of each of the faces (as angry, disgusted, happy or neutral) and gave an emotional intensity rating (on a scale of 1 to 7). They then completed the Beck Depression Inventory (BDI; Beck, Steer, & Brown, 1996), the state and trait versions of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs,

1983) and the TDDS (Three Domains Disgust Scale; Tybur, Lieberman, & Griskevicius, 2009). Disgust sensitivity was used in the analysis, whereas measures of depression and anxiety were taken to determine whether or not the two manipulation groups differed in key mood-related variables known to influence emotion processing (Bishop, Duncan, & Lawrence, 2004; Bishop, Jenkins, & Lawrence, 2007; Cavanagh & Geisler, 2006).

EEG recording

EEG data were sampled at a digitization rate of 1000 Hz using a Synamp amplifier (Neuroscan) using a 100 Hz low-pass filter (with a 50 Hz notch filter enabled) and DC-recorded with a linked-earlobe reference. They were downsampled to 500 Hz and subjected to an offline bandwidth filter of .1 to 40 Hz (the .1 high pass filter was utilised following the recommendations for LPP research given by Hajcak, Weinberg, MacNamara and Foti, 2012). Signals were recorded from 26 electrodes (FP1, FP2, F7, F3, Fz, F4, F8, FC5, FC1, FCz, FC2, FC6, O2, C3, Cz, C4, O1, CP5, CP1, CP2, CP6, P7, P3, Pz, P4 and P8 according to the international 10-20 system). Horizontal eye movements (HEOG) were measured from two electrodes placed at the outer canthi of the eyes. Impedances on all electrodes were kept below 5 kΩ. The EEG data were epoched using a pre-stimulus baseline of 100 ms and a window that continued until 1000 ms post-stimulus. Artefact rejection was conducted using a moving peak-to-peak window with trials with horizontal eye movements (HEOG exceeding ±30 µV) and eye blinks (FP1 and FP2 exceeding ±60 µV) rejected. Trials were rejected as artefacts when the voltage exceeded ±100 µV at any other electrode.

EEG data analysis

All analyses were conducted using a mean amplitude measure averaged across regional clusters of electrodes defined a priori and based on previous research. Time windows were computed based on visual inspection of the grand average waveforms (collapsed across conditions and emotions). The EPN component was measured over occipito-parietal electrodes P7, P8, O1 and O2 over a time window of 240-310 ms. The LPP was measured from centro-parietal electrodes P3, Pz, P4, Cz, CP1 and CP2 over a large time window of 250-900 ms that was divided into an early, mid and late phase (250-450 ms, 450-650 ms and 650-900 ms respectively).

The primary analysis for each component was a 2 x 2 x 2 mixed analysis of variance (ANOVA) with emotional expression (disgusted or neutral) and decision (emotion or gender) entered as within-subject factors and condition (experimental or control) entered as a between-subject factor. In order to assess whether any differences between the disgusted and neutral stimuli were specific to disgust, rather than reflecting emotional or valence modulation more generally, the analyses were conducted again using the mean amplitude for both angry and happy expressions rather than disgusted. Significant between-group main effects and interactions were followed by a separate 2 x 2 (emotion and decision) within-subject ANOVA performed on each experimental group individually. Following effects involving emotion or decision, correlations with disgust sensitivity were examined. Analyses were conducted using Greenhouse-Geisser adjustments and trials where participants were prompted to respond (10% of the trials) were not included.

Results

Behavioural

There were no significant difference between the experimental and control groups on BDI, TDDS, trait and state STAI scores (see Table 1). The two groups had similar ability to classify the angry, happy, neutral and disgusted faces correctly according to their NimStim classification (mean correct classifications of 74.1% and 75.0% for angry, 97.1% and 100% for happy, 82.1% and 82.3% for disgusted, and 92.9% and 95.5% for neutral for experimental and control groups respectively). The groups did not differ in their ratings of arousal in response to the expressions (means of 5.34 and 4.78 for angry, 4.87 and 4.91 for happy, 5.63 and 5.33 for disgusted, and 4.56 and 3.14 for neutral for experimental and control groups respectively) according to between-subject *t* tests (all *t*s < 1.90).

ERP Analyses

EPN (240-310 ms post-stimulus onset)

There was an enhanced EPN for disgusted compared to neutral expressions (means of 3.90 and 4.35 µV respectively (F(1, 21) = 5.58, p = .029, η_p^2 = .21; see Figure 1) but no other main effects or interactions (all Fs < 1.84). A difference index was calculated by subtracting the mean amplitude for neutral trials from that for disgusted trials (collapsed across conditions); there was a trend towards this index increasing with disgust sensitivity, but this correlation was not significant (r = .37, p = .09).

The same analysis conducted on angry expressions revealed a significant interaction between condition and emotion (F(1, 21) = 4.38, p = .049, η_p^2 = .17), with the experimental group having a marginally more negative mean amplitude for angry than neutral expression (3.75 and 4.37 µV respectively). There was no difference for the control group (means of 4.49 and 4.33 µV for angry and neutral respectively). This analysis conducted on happy facial expressions revealed an enhanced EPN for happy faces over neutral ones (F(1, 21) = 13.86, p = .001, η_p^2 = .40) but no other effects (all Fs < 2.85).

LPP early phase (250-450 ms post-stimulus onset)

For the disgusted expression analysis, there were no significant effects for the early phase of the LPP (all Fs < 2.83). Similarly there were no significant effects for the analysis on angry (all Fs < 2.12) or happy (all Fs < 3.72) expressions.

LPP mid phase (450-650 ms post-stimulus onset)

There was an interaction between condition, type of decision and emotion at the mid phase LPP (F(1, 21) = 6.07, p = .022, η_p^2 = .22; see Figure 2 for grand average ERPs and Figure 3 for scalp maps). Separate ANOVAs on the two conditions showed that there was no interaction between type of decision and emotion for the control group (F = .63) but the interaction was significant for the experimental group ($F(1, 11) = 8.97$, p = .012, η_p^2 = .45). Further analyses revealed a larger LPP amplitude for disgusted expressions when an emotional rather than a gender decision was made with means of 5.19 and 3.82 µV respectively ($t(11) = 2.26$, p = .045). There was no difference for neutral expressions with means of 3.44 and 3.68 µV for emotional and gender decisions respectively ($t(11) = -.55$), p = .59). The difference between mean amplitudes for disgusted expressions, in the experimental condition, when emotional and gender decisions were made was calculated; this value did not correlate significantly with disgust sensitivity (r = -.26, p = .42). No significant effects were revealed in analyses of angry versus neutral (all Fs < 2.90) or happy versus neutral (all Fs < 1.95) expressions.

LPP late phase (650-900 ms post-stimulus onset)

In this phase there was a main effect of decision ($F(1, 21) = 7.23$, p = .014, η_p^2 = .26) where the LPP was enhanced for emotional over gender decisions. As with the mid phase, there was also a significant interaction between condition, type of response and emotion ($F(1, 21) = 5.30$, p = .032, η_p^2 = .20). Separate ANOVAs on the two conditions revealed that the LPP was enhanced for emotional compared to gender decisions in the experimental group $F(1, 11) = 5.23$, p = .041, η_p^2 = .33) but not in the control group (F = 2.26). As with the mid phase, the amplitude difference for the experimental condition between emotion or gender decisions in response to disgusted faces, did not correlate with disgust sensitivity (*r = -.05*, p = .80). An analysis of angry and neutral expressions revealed non-significant differences (all Fs < 3.35). However, there was a strong enhancement of the LPP for emotional over gender decisions ($F(1, 21) = 12.24$, p = .002, η_p^2 = .37) when happy expressions were used in place of disgusted ones, although there were no effects related to the emotional content of the stimuli or the condition (all other Fs < .83).

Discussion

The experiment investigated whether prior exposure to disgusting imagery affects the subsequent processing of disgusted facial expressions and whether explicit conscious appraisal is necessary to facilitate this influence. Consistent with previous research, the EPN was modulated by the disgusted facial expressions but there were no prior exposure or appraisal effects. The LPP was influenced by whether or not the participant had been exposed to disgusting imagery, with the positivity enhanced for disgusted, relative to neutral, facial expressions following exposure. The latter effect only emerged when the participants were instructed to focus on the emotion of the stimuli, rather than the gender. These results highlight the ways in which visual processing of emotionally salient stimuli can be affected by prior emotional exposure and how emotional processing is driven by an interaction between stimulus properties and top down cognitive and mood influences.

Disgusted compared to neutral expressions evoked an enhanced EPN that was unaffected by prior exposure to disgusting imagery or by the nature of the decision. Later processes were influenced by both the type of decision made and the nature of the prior exposure, with an augmented LPP evoked for disgusted compared to neutral expressions but only after exposure to disgusting images *and* when there was a focus on the emotional rather than the non-emotional aspects of the expression.

The effect of disgust exposure and emotional engagement over the LPP

Prior exposure to disgusting imagery influenced the processing of disgusted facial expressions – an effect that only occurred when the emotion of the face was explicitly considered and one that was restricted to the LPP. This pattern was most clearly observed in the middle time window of 450-650 ms post-stimulus onset. This effect was diminished in the late phase, where the cognitive influence of the task decision came to exert a more potent effect. This is consistent with the notion that the LPP is modulated by both emotional and cognitive factors (Foti & Hajcak, 2008; MacNamara et al., 2009; Weinberg & Hajcak, 2011) and that the balance between these influences changes across the length of the wave as the potency of the emotional content of the stimuli diminishes in effect relative to other influences (Weinberg et al., 2012).

The results here indicate that exposure to disgust affects processing of disgusted expressions, but only when engaging in emotional appraisal of the expression. There was also an enhancement in the late phase of the LPP as a result of having made an emotional decision that was not tied to the properties of the stimuli, thus providing further support for the notion that the latter part of the LPP is more driven by top-down cognitive processes than by the properties of the stimuli. However, this enhancement was further increased in the experimental group where participants had been exposed to disgusting videos. It is possible that such emotional exposure primed participants to devote more cognitive resources to emotional reflection and thus engage with the emotional evaluation task more than they would have otherwise.

Taken together with the EPN results, it appears as though early independent main effects of emotion and later cognitive effects can be observed, and that the middle phase of the LPP represents the point at which these processes integrate and the bottom-up emotional content of facial expressions is contextualised with top-down prior experience and conscious evaluation. Inducing the sensation of disgust in individuals in the short term has been found to influence numerous behavioural tasks (Helzer & Pizarro, 2011; Van Dillen, van der Wal, & van den Boss, 2012; Wheatley & Haidt, 2005; Zhong et al., 2010); the data here illustrates that an early electrophysiological effect in early visual processing can also emerge. As the present study found this effect to interact with explicit consideration of the emotion of the stimuli, and previous research has found that such exposure impacts reflective decision making, it is possible that it is the conscious experience of disgust (rather than a reconfiguration of a more implicit processing system) that is influenced by such disgust manipulations.

These effects across the LPP were not found to be influenced by disgust sensitivity. It is possible that the mood manipulation used in this experiment was sufficiently strong to wash out such influences so that even individuals with low disgust sensitivity were more primed towards increased representation of disgusted facial expressions. Alternatively, it could be that disgust sensitivity is not able to exert an influence at the earliest stages of emotional perception. The emotional LPP effects for disgusted expressions were not mirrored for angry or happy expressions thus indicating that broader emotional (or valence) modulation was not sufficient to account for the results. The extent to which emotional discrimination occurs within the LPP is unclear, though the results here indicate that viewing disgusting imagery may be able to exert a specific influence over the processing of subsequent disgusted facial expressions under particular circumstances as a result of interactions with specific cognitive and priming influences.

Emotional modulation of the EPN

Consistent with previous research (Balconi & Pozzoli, 2003; Eimer, Holmes, & McGlone, 2003), we observed an enhanced EPN for emotional relative to neutral stimuli. This emotional modulation occurred independently of experimental condition or decision for disgusted and happy expressions; however, for the angry faces, this modulation of the EPN interacted with the condition and decision. There is some evidence that disgust enhances the EPN relative to other emotions (Ashley, Vuilleumier, & Swick, 2003; Wheaton et al., 2013) though the EPN is most reliably modulated by emotion more broadly. Here the EPN was the only examined component where an emotional effect was observed that was not tied to the experimental conditions. For the disgusted expressions, these results are consistent with the notion that the EPN can emerge as a result of the automatic attentional capture of emotional stimuli (Schupp, Öhman et al., 2004, Schupp, Stockburger et al., 2006).

Given the considerable overlap that is known to exist between the facial representations of disgust and anger (Pell & Richards, 2011, 2013; Skinner & Benton, 2010), it is possible that this component, that was enhanced for disgust regardless of condition, was enhanced for anger as well in individuals who were exposed to disgust who may have been primed to process the structural components of angry expressions also present in disgusted expressions. There was also some evidence from participants' classification of expressions that the disgusted and happy expressions used in this experiment were better exemplars than the angry expressions (with participants classifying fewer angry faces correctly); it is possible that the greater degree of ambiguity present in the angry faces contributed to this different pattern of results in the EPN.

Disgust sensitivity is a long-term correlate of numerous psychological variables, but, as with the LPP, the present study failed to find a significant EPN modulation for disgusted over neutral expressions as a result of disgust sensitivity. The extent to which disgust sensitivity can affect emotional perception as well as longer term behavioural and psychological correlates is still unclear and remains a subject worth investigating further. It would be particularly instructive for future researchers to examine ERPs evoked by disgusted expressions in a sample of individuals rating high on disgust sensitivity. The present results clearly indicate, however, that the modulation of the EPN or LPP in response to disgusted facial expressions is not contingent on having high disgust sensitivity.

Conclusion

This experiment demonstrates that prior exposure to disgusting imagery affects the processing of disgusted facial expressions, but only when the emotion is subject to conscious appraisal. Task free emotional modulation for disgusted expressions was found in the EPN, with this information integrated with mood manipulation and emotional appraisal across the mid and late phases of the LPP. The EPN was enhanced for disgusted relative to neutral expressions regardless of condition or decision, whereas disgusted faces were enhanced (relative to neutral) in the LPP only following prior exposure to disgusting imagery, and only when the emotion of the face was the subject of conscious appraisal. Emotional appraisal also influenced the late phase of the LPP independently of the stimuli, particularly following exposure to disgusting imagery. Results have important implications for the ways in which the emotional properties of stimuli interact with top-down cognitive factors and mood to affect visual processing.

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Tables

Table 1. Questionnaire scores for the experimental and control groups.

	Experimental group mean (*SD*)	Control group mean (*SD*)
Age	27.25 (6.78)	27.55 (8.66)
BDI	5.67 (5.55)	4.55 (5.84)
TDDS	65.67 (24.10)	75.64 (18.54)
Trait STAI	34.67 (10.12)	37.18 (9.70)
State STAI	30.08 (8.58)	32.55 (12.27)
Males:Females	8:4	7:4

Captions

Figure 1. EPN for disgusted and neutral expressions (collapsed across conditions).

Figure 2. LPP for the control (top panel) and experimental (bottom panel) groups for emotion and gender decisions in response to disgusted and neutral expressions.

Figure 3a. Difference in mean amplitude between disgusted and neutral expressions in each LPP window for the control condition, the top and bottom rows show emotion and gender decisions respectively.

Figure 3b. Difference in mean amplitude between disgusted and neutral expressions in each LPP window for the experimental condition, the top and bottom rows show emotion and gender decisions respectively.