Gender moderates valence effects on the late positive potential to emotional distracters

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Attention is captured more strongly by emotional pictures than by neutral pictures. This allocation of attention to emotional pictures is commonly indexed by the late positive potential (LPP), an event-related potential (ERP) that is larger for negative and positive pictures than for neutral pictures. However, findings are mixed in regards to valence effects, that is, whether the LPP is larger for negative pictures than for positive pictures (negativity bias) or vice versa (positivity bias). Additionally, previous ERP studies have not explicitly considered a moderating effect of gender. In the present study, positive, negative, and neutral pictures were shown at fixation but were always task-irrelevant. Results showed that LPP amplitudes for the positive and negative distracters were moderated by gender. Men showed a positivity bias on the LPP. Women did not show a clear valence bias on the LPP, but they showed a negativity bias on picture ratings. These gender differences for the LPP did not habituate, as they were obtained even for pictures that were repeated 20 times. Because previous studies with other measures suggest a positivity bias for men and a negativity bias for women, the present findings extend these studies suggesting that attention allocation for emotional pictures of different valence is similarly moderated by gender.

Although the human perceptual system has a limited capacity (Marois & Ivanoff, 2005), selective attention helps in directing perceptual resources to task-relevant information at the expense of task-irrelevant information (Luck & Vecera, 2002). Some stimulus features, however, may be relevant to survival even though they are irrelevant to the ongoing task. Emotional stimuli are inherently survival-relevant and should capture attention regardless of whether the emotional stimuli are relevant to the task. In support of this, many behavioral studies have shown robust effects of emotion on attention (Vuilleumier & Huang, 2009). Thus, orienting to emotional information prepares us for action to events that have motivational significance for us (Ferrari, Bradley, Codispoti, Karlsson & Lang, 2012). The notion that effects on perceptual processing may be similar for emotion as for voluntary, directed attention has been referred to as motivated attention (Lang, Bradley & Cuthbert, 1997; Lang & Bradley, 2010) or emotional attention (Pourtois, Schettino & Vuilleumier, 2013).

Event-related potentials are a common method to examine motivated attention. Research indicates that when participants view emotional (i.e., pleasant or unpleasant) pictures and neutral pictures, they show a late positive potential (LPP) for emotional versus neutral pictures regardless of task relevance (Sand & Wiens, 2011; Schupp, Flaisch, Stockburger, Junghöfer & Jungho, 2006; Wiens, Sand, Norberg & Andersson, 2011). These findings are consistent with the view that the LPP indexes motivational significance or the degree to which selective attention is allocated incidentally or naturally to emotional pictures (Bradley, 2009; Olofsson, Nordin, Sequeira & Polich, 2008).
The motivational model of emotion (Lang et al., 1997; Lang & Bradley, 2010) postulates that picture ratings of arousal reflect the degree to which attention is captured by negative pictures (mediated by a defense system) and positive pictures (mediated by an appetitive system). The defense system handles threatening stimuli (e.g., predators and conspecifics), whereas the appetitive system handles preserving stimuli (e.g., related to nurturing, ingestion, copulation) (Lang et al., 1997; Lang & Bradley, 2010), and the amygdala plays a major role in both systems (Pourtois et al., 2013). Notably, with increases in arousal, amygdala activation is believed to increase more strongly for the defense system than the appetitive system, resulting in a negativity bias (Carretié, Albert, López-Martín & Tapia, 2009). Previous research has shown that when affective pictures are rated on valence and arousal, the rated arousal increases more for negative pictures (decrease in valence) than for positive pictures (increase in valence), giving a steeper slope for negative pictures in ratings (Bradley & Lang, 2007a). Lastly, it has been found that the amplitude of LPP to negative pictures is larger than to both positive and neutral pictures (Ito, Larsen, Smith & Cacioppo, 1998).

However, evidence for such a negativity bias for the LPP and other ERP measures is mixed. Whereas some studies found support for a negativity bias (Delplanque, Silvert, Hot, Rigoulot & Sequeira, 2006; Ito et al., 1998; Kaestner & Polich, 2011; Smith, Cacioppo, Larsen & Chartrand, 2003), many other studies found a positivity bias in which positive pictures elicited larger LPPs than negative pictures did (Ferrari, Codispoti, Cardinale & Bradley, 2008; Schupp, Junghöfer, Weike & Hamm, 2004; Schupp, Stockburger, Codispoti, Junghöfer, Weike & Hamm, 2006; Schupp, Junghöfer, Weike & Hamm, 2007). Still other studies found no valence differences in ERPs (Bianchin & Angrilli, 2012; Foti, Hajčak & Dien, 2009; Franken, Muris, Nijs & Strien, 2008; Rozenkrants & Polich, 2008; Weinberg, Hilgard, Bartholow & Hajcak, 2012). A comparison of these studies does not show a clear pattern except that experiments with passive viewing, larger samples, and balanced gender groups resulted in a positivity bias or no bias at all (Ferrari et al., 2008; Foti et al., 2009; Franken et al., 2008; Rozenkrants & Polich, 2008; Schupp et al., 2004; Schupp et al., 2007; Schupp et al., 2006; Weinberg et al., 2012).

Importantly, these studies did not explicitly consider gender differences with one exception (Bianchin & Angrilli, 2012). The reported gender differences for LPP, however, are inconclusive because effects were obtained only for a nonstandard electrode (F7) and in opposite direction than expected (i.e., amplitudes were lower for positive than neutral pictures) (Bianchin & Angrilli, 2012). However, consistent gender differences to emotional pictures have been found on self-reported ratings, and also on peripheral and central measures (Bradley, Codispoti, Sabatinelli & Lang, 2001; Bradley & Lang, 2007a; Stevens & Hamann, 2012). In reported arousal and valence ratings, women rated negative pictures as more arousing and unpleasant than men did, whereas men rated positive pictures as more arousing and pleasant than women did (Bradley & Lang, 2007a). Also, women showed greater facial EMG activity, bradycardia, startle eye blink magnitude, and electrodermal reactivity to negative pictures, whereas men showed greater electrodermal reactivity to erotic pictures (Bradley et al., 2001). Furthermore, an extensive review (Whittle, Yücel, Yap & Allen, 2011), and a large meta-analysis of fMRI studies (n = 88) found that women were more reactive to negative pictures whereas men were more reactive to positive
pictures (Stevens & Hamann, 2012). Taken together, research suggests that women tend to show a negativity bias whereas men tend to show a positivity bias.

Although clear gender differences have been observed on many measures, previous ERP studies on valence effects (i.e., negativity or positivity bias) have not explicitly considered effects of gender. Thus, gender effects might resolve the mixed results regarding a positivity or negativity bias. To address this question, the present study recorded the LPP to positive, negative, and neutral pictures in a gender-balanced sample to examine the moderating role of gender on valence effects on the LPP. Pictures were shown at fixation, but they were always task-irrelevant to minimize confounding effects of gender differences in voluntary attention to the emotional pictures (Okon-singer & Tzelgov, 2007). Habituation was also manipulated by showing the pictures either 20 times or 5 times (Rankin et al., 2009). Research suggests that emotional pictures do not easily lose their motivational significance. Specifically, LPP amplitudes are reduced by picture repetition but remain larger for emotional pictures than for neutral pictures despite substantial repetition (Codispoti, Ferrari & Bradley, 2006, 2007; Ferrari, Bradley, Codispoti, & Lang, 2011). Thus, the present design tested whether or not gender differences in valence effects for the LPP would be observed even after extensive picture repetitions.

To conclude, the prediction was that gender would moderate valence effects for the LPP and the self-reported arousal ratings to emotional distracters, with men showing a positivity bias and women showing a negativity bias for both measures. Further, the prediction was that these effects would not habituate and thus, would be apparent even after 20 picture repetitions.

Method

Participants
Participants were recruited from the Psychology Department at Stockholm University. The final sample consisted mainly of 34 introductory course students in psychology with a mean age of 24.5 (SD = 5.5). The mean age of men (N = 17) was 23.24 (SD = 3.4) and women (N = 17) 25.82 (SD = 6.93) with no gender difference (p = .18). State and trait anxiety was measured with the State-Trait Anxiety Inventory (Spielberger, 1983). Mean trait anxiety was 44.1 (SD = 9.6) and mean state anxiety was 35.0 (SD = 6.5) with no gender differences (p > .50). The study was approved by the regional ethics board and was conducted in accordance with the Helsinki declaration. Participants gave their informed consent and received either course credit or two movie vouchers for participating.

Apparatus
Pictures were shown in color and were taken from the International Affective Picture Set (IAPS) (Lang, Bradley & Cuthbert, 2008). From this set, 150 pictures were chosen to target one of three valence categories (50 pictures per category): neutral, positive, and negative. Neutral pictures had valence ratings between 4 and 6 and arousal ratings less than 5. Positive pictures had valence ratings above 6 and arousal ratings above 5. Negative pictures had valence ratings below 4 and arousal ratings above 5. The pictures were not selected in terms of their thematic content. Instead, the pictures were randomly selected 50 at a time from the IAPS data set until the selection process fulfilled the following criteria. In terms of normative ratings (across gender)
for valence and arousal, the positive and the negative sets differed significantly ($p < .001$) from the neutral set, whereas the positive and the negative set differed only on valence ($p < .001$) but not arousal ($p < .50$).

Pictures were shown on a 21” View Sonic p227f CRT-screen with a refresh rate of 100 Hz and a resolution of 1280 x 1024 pixels. Picture size was 15.5 cm (11.1º) wide and 11 cm (7.9º) high. The background was dark grey. Viewing distance was 80 cm and was maintained with a chin rest, and the experimental software was Presentation 14.8 (Neurobehavioral Systems, Albany, CA).

The EEG apparatus was an Active Two Biosemi system (Biosemi, Amsterdam, Netherlands) with 128 electrodes (http://www.biosemi.com/headcap.htm). Data were sampled at 512 Hz and filtered with a hardware low-pass filter at 104 Hz and an offline notch filter at 50 Hz.

**Procedure**

Each trial consisted of a 200-ms IAPS picture presented in the middle of the screen followed by a fixation cross for with a random interval of 1500 to 1800 ms. Participants were instructed that on some trials, two identical letters would be shown (to the left and right of fixation). Their task was to push the left control button for N and the right control button for M. In one task, the letters were superimposed on the pictures, and in the other task, the letters were shown to the left and right of the pictures.

Each task consisted of two picture conditions: repeated (i.e., pictures were repeated 20 times) and new (i.e., pictures were repeated 5 times). Order of task and condition was counterbalanced (Latin square) across subjects. For each subject, the picture set of 50 pictures per emotion (neutral, positive, and negative) was randomly divided into two sets of 25 pictures, one for each task. Within each task, the 25 pictures from each category were further divided randomly into a set of 5 pictures for the repeated condition and a set of 20 pictures for the new condition.

Each picture condition consisted of four blocks. In the repeated condition, the same 5 pictures in each category were used in each of 4 blocks so that each block consisted of 75 trials: 3 emotions, 5 pictures per category, and 5 repetitions. The new condition differed from the repeated condition only in that 5 different pictures from each category were used in each block (i.e., 5 repetitions vs. 20 repetitions in the repeated condition). Within each block, trial order was randomized for each subject. Letters were shown together with the picture on 20% of the trials (in each task), and no letter was shown in the remaining 80% of trials. After the four blocks, participants rated each IAPS picture (200 ms) on valence and arousal with the computerized version of the self-assessment mannequin scale (Bradley & Lang, 2007b).

**Data reduction**

BESA software (version 5.3.7, Besa Software GmbH, Gräfelfing, Germany, www.besa.de) was used for offline processing, and the EEG data were processed as in previous studies (Wiens et al., 2011; Wiens et al., 2011; Wiens, Molapour, Overfeld & Sand, 2012). ERP epochs were extracted (only for trials without letters and without button presses) from 100 ms before to 850 ms after picture onset (-100 to 0 ms was
used for baseline correction). Data were re-referenced to the arithmetic average of all electrodes. The middle panel in Figure 1 shows the topography of the mean amplitude difference between 400 and 600 ms for emotional pictures versus neutral pictures across tasks and conditions. Visual inspection of the grand mean difference waves between emotional (positive and negative combined) and neutral pictures across conditions showed that the LPP was maximal in the 400-600 ms range after stimulus onset on centro-parietal electrodes (A01-A05, A19, A32, B01, B02, C01, D01, D15 and D16) Wiens et al., 2011; Wiens et al., 2011; Wiens et al., 2012). Mean amplitudes were extracted across these electrodes for this interval for each participant. Mean ERP waves for each emotional category (Figure 1, right panel) were calculated for both genders across tasks and conditions.

The emotion ratings and LPP amplitudes were analyzed separately in a mixed-design ANOVA with the between-subjects variable gender and the within-subjects variables: task (letters on picture or outside picture), emotion (neutral, positive, negative), repetition (repeated, new), and block (1 to 4). Additional ANOVAs showed that state or trait anxiety as covariates did not change the results. P1 and EPN were also extracted amplitudes and performed similar analyses as for the LPP (Wiens et al., 2011). Because effects of emotion did not interact with either gender, or repetition, or both, these results are not reported. Further, preliminary analyses showed that task performance was near ceiling in both tasks ($d' > 4.04$). The task and condition order of the participants did not differ by gender, $\chi^2(1, N=34) = 2.11, p = .55$. Because the ANOVAs showed that neither task nor block interacted with any variable of interest, their effects are not reported below. ANOVA results were corrected with a Greenhouse-Geisser correction (but uncorrected $dfs$ are shown for readability). Significance level was alpha $< .05$, two-tailed.

Results

Results for LPP amplitudes and emotion ratings are shown in Figures 1 to 4. Note that for each subject, the IAPS pictures from each valence category were assigned randomly to different conditions (of task and repetition). Therefore, LPP amplitudes and emotion ratings refer to identical pictures within a subject but to different pictures across subjects.

LPP
The left panel in Figure 1 shows LPP-relevant mean amplitudes for the three emotions, for women and men separately. A mixed-design ANOVA with gender (women, men) as a between-subjects factor, and condition (new, repeated), and emotion (neutral, positive, negative) as within-subjects factors of the mean LPP amplitudes showed an interaction of gender and emotion (neutral, positive, negative), $F(2, 64) = 5.04, p = .013, \eta^2 = .14$. This effect was mainly driven by an interaction between gender and valence (positive, negative), $F(1, 32) = 7.26, p = .011, \eta^2 = .19$. A priori planned contrasts showed that for men, amplitudes were larger for positive pictures than for negative pictures, $F(1, 16) = 30.25, p < .001, \eta^2 = .65$. For women, amplitudes did not differ between positive and negative pictures, $F(1, 16) = 2.74, p = .117, \eta^2 = .15$. 
Figure 1. The left panel shows mean late positive potential (LPP) amplitudes (400-600 ms, ±95% CI, Cousineau–Morey adjusted) for neutral, positive, and negative pictures by gender. The 95% Cousineau–Morey adjusted CIs refer to the estimated within-condition variability after removal of between-subjects differences (Baguley, 2012) and are useful to compare conditions within groups: if the CIs of two conditions do not overlap, the conditions differ significantly at p < .05. The middle panel shows the topography of the mean amplitude difference between 400 and 600 ms for emotional pictures versus neutral pictures across tasks and conditions. The green dots show the LPP-relevant electrodes that were combined to compute mean LPP amplitudes in the left and right panels. The right panel shows the mean ERP waves for neutral, positive, and negative pictures across the LPP-relevant electrodes, separately for women (top) and men (bottom) across tasks and conditions.

Note that an analysis of only the data from the repeated conditions (i.e., 20 picture repetitions) yielded similar findings. In this condition, the interaction between gender and valence (negative, positive) was significant, $F(1, 32) = 6.29$, $p = .017$, $\eta^2 = .16$. For men, amplitudes were larger for positive than for negative pictures ($p = .002$), whereas for women, amplitudes did not differ between positive and negative pictures ($p = .74$).

The ANOVA also showed an interaction between emotion and repetition, $F(2, 64) = 6.21$, $p = .004$, $\eta^2 = .16$. Importantly, this interaction was not qualified by a higher-order interaction with gender, $F(2, 64) < 1$, $p = .82$, $\eta^2 < .01$. The emotion by repetition interaction is illustrated in Figure 2. Mean amplitudes decreased from the new condition to the repeated condition more strongly for positive pictures than negative pictures, $F(1, 32) = 4.45$, $p = .043$, $\eta^2 = .12$, and more strongly for positive pictures than neutral pictures, $F(1, 32) = 14.89$, $p = .001$, $\eta^2 = .32$. Effects of repetition did not differ between negative and neutral pictures, $F(1, 32) = 1.30$, $p = .262$, $\eta^2 = .04$. 
Figure 2. Mean LPP (±95% CI, Cousineau–Morey adjusted) amplitudes for neutral, positive, and negative pictures, for new and repeated pictures separately.

Emotion ratings
Figure 3 shows arousal ratings for the three valence categories, for women and men separately. A mixed-design ANOVA with gender (women, men) as a between-subjects factor, and condition (new, repeated), and emotion (neutral, positive, negative) as within-subjects factors of arousal ratings showed an interaction of gender and emotion (neutral, positive, negative), $F(2, 64) = 4.07, p = .028, \eta^2_p = .11$. The interaction between gender and emotion (negative, positive) was also significant, $F(1, 32) = 5.71, p = .023, \eta^2_p = .15$. A priori planned contrasts showed that for men, arousal ratings did not differ between negative and positive pictures, $F(1, 16) < 1, p = .61, \eta^2_p = .02$. For women, arousal ratings were larger for negative pictures than positive pictures, $F(1, 16) = 17.85, p = .001, \eta^2_p = .53$. The ANOVA showed that the gender by emotion by repetition interaction was not significant, $F(2, 64) = 2.18, p = .12, \eta^2_p = .06$, but that the emotion by repetition interaction was significant, $F(1, 32) = 3.37, p = .041, \eta^2_p = .09$. This suggests that emotional pictures were rated as less arousing if they were repeated rather than new.
Figure 3. Mean arousal ratings (±95% CI, Cousineau–Morey adjusted) for neutral, positive, and negative pictures by gender.

Figure 4 shows valence ratings for the three valence categories, for women and men separately. A mixed-design ANOVA with gender (women, men) as a between-subjects factor, and condition (new, repeated), and emotion (neutral, positive, negative) as within-subjects factors of valence ratings showed an interaction between gender and emotion, $F(2, 64) = 4.93, p = .024, \eta^2_p = .13$. As shown in Figure 4, women rated negative pictures as more unpleasant than men did ($p < .001, \eta^2_p = .32$) but gave similar ratings for neutral and for positive pictures ($p > .48$). The ANOVA showed that the gender by emotion by repetition interaction was not significant, $F(2, 64) < 1, p = .45, \eta^2_p = .03$, but that the gender by repetition interaction was significant, $F(1, 32) = 4.75, p = .037, \eta^2_p = .13$. This suggests that women tended to rate pictures as less pleasant if they were repeated rather than new, whereas men tended to show the opposite pattern.
Figure 4. Mean valence ratings (±95% CI, Cousineau–Morey adjusted) for neutral, positive, and negative pictures by gender.

Discussion

The main finding of this study was that valence effects on LPP amplitudes and emotion ratings were moderated by gender. Men showed larger LPP amplitudes for positive pictures than for negative pictures (i.e., positivity bias), whereas women did not show differences in LPP amplitudes for positive and negative pictures. However, women showed a negativity bias on arousal ratings in that they rated negative pictures as more arousing than positive pictures. Notably, the LPP decreased as a result of repetition for only the positive pictures, although this decrease did not differ between men and women.

The present findings of gender effects extend previous ERP studies on valence effects for emotional pictures (Delplanque et al., 2006; Ferrari et al., 2008; Foti et al., 2009; Franken et al., 2008; Ito et al., 1998; Kaestner & Polich, 2011; Rozenkrants & Polich, 2008; Schupp et al., 2004; Schupp et al., 2006; Schupp et al., 2007; Weinberg et al., 2012). Specifically, the present findings demonstrate that attention allocation to emotional pictures of different valence is moderated by gender. These findings are in accordance with studies that have shown that women showed greater facial EMG activity, bradycardia, startle eye blink magnitude, and electrodermal reactivity to negative pictures, whereas men showed greater electrodermal reactivity to erotic pictures (Bradley et al., 2001; Bradley & Lang, 2007a). MRI studies suggest that especially men are reported to be more reactive to erotic stimuli compared to women (Hamann, Herman, Nolan & Wallen, 2004; Sabatinelli, Flaisch, Bradley, Fitzsimmons...
& Lang, 2004). Further, extensive fMRI research in affective processing of emotional content has found that women were more reactive to negative pictures.

These findings suggest that there are systematic gender differences in emotional reactivity and that these differences are reflected in differences in brain activation to emotional pictures (Domes et al., 2010; Whittle et al., 2011; Stevens & Hamann, 2012). These differences may also be affected by differing strategies of emotional regulation (McRae, Ochsner, Mauss, Gabrieli & Gross, 2008, Domes et al., 2010; Whittle et al., 2011), combined with attentional biases (Whittle et al., 2011; Moriguchi, Touroutoglou, Dickerson & Barrett, 2013). Research show that gender differences to emotional pictures starts as early as the age of 7-11 years, with girls rating negative content as more negative, showing greater startle EMG and skin conductance reactivity than boys (McManis, Bradley, Berg, Cuthbert & Lang, 2001). Ultimate explanations for gender differences in emotional reactivity are cultural influences (Brody, 1997), hormonal differences (Krug, Plihal, Fehm & Born, 2000; Kret & De Gelder, 2012), and evolutionary explanations (Geary, 1998).

As an additional finding, the general habituation effects on the emotional LPP varied with valence, but this effect was not moderated by gender. As in previous studies, LPP amplitudes were larger for both positive and negative pictures than for neutral pictures, and this emotional modulation habituated with picture repetition but remained significant even after 20 repetitions (Codispoti et al., 2006, 2007; Ferrari et al., 2011). However, the present results suggest that this habituation effect varies with valence, as LPP amplitudes decreased more strongly for positive pictures than for negative pictures. These differences were not moderated by gender. These findings support the notion of a negativity bias (Bradley & Lang, 2007a; Carretié et al., 2009; Ito et al., 1998). The present findings indicate that although overall LPP amplitudes may not show a negativity bias, the LPP amplitudes for negative pictures may resist habituation more strongly than for positive pictures. If so, motivational significance may be maintained longer for negative pictures than for positive pictures, presumably because of the greater survival relevance of negative stimuli than positive stimuli (Lang et al., 1997).

Notably, research suggests that emotional responses of women vary with their menstrual cycle. For example, LPP amplitude is higher to erotic pictures than to other emotional categories in women during their ovulatory phase (Krug et al., 2000). Because our study contained mainly erotic pictures as positive pictures and did not measure or control for menstrual cycle, it is important to consider potentially confounding effects on our results. On one hand, if women varied considerably in their LPP responses to the erotic pictures, then the LPP responses to positive versus neutral pictures would have shown larger variability (i.e., larger variance) for women than men, but a Levene's test found no significant difference (if anything, men had larger variance). On the other hand, Krug et al., (2000) did not include men in their sample; thus, the hormonal effect on erotic content in women has not been directly compared with men, leaving uncertainty in possible gender biases due to hormonal differences. To conclude, because it is reasonable to assume that the women in our sample varied randomly in their menstrual cycle, our results suggest that there is a

\[1\] Mean amplitude in LPP for positive - neutral for men was 1.22 (SD = .54) and women .90 (SD = .41). Levene's test for equality of variance \( p = .188. \)
general difference between men and women in their LPP responses to positive pictures. However, future research is needed to determine how much this difference varies with menstrual cycle.

Another concern is that the ERP method does not allow any direct comparison of ERP and fMRI results between studies. Even if there are differing regional activation between men and women, these differences should be treated cautiously in an ERP experiment. Because of the inverse problem, there is an infinite number of possible solutions for a given scalp distribution (i.e. even if there are differences in regional activity the scalp distribution may be the same) (Luck, Woodman & Vogel, 2000). One solution is to combine fMRI and ERP recordings to emotional pictures. Studies have shown that the source of the LPP is originating from both visual areas and subcortical structures (Sabatinelli, Lang, Keil & Bradley, 2007; Sabatinelli, Keil, Frank & Lang, 2012). Stereologic morphometry shows that there are structural differences in visual cortex between men and women, the visual cortex in men has higher neuronal density (Rabinowicz, Dean, Petetot & de Courten-Myers, 1999). Thus, one possible explanation for the LPP amplitude difference for men and women could be structural differences in the visual cortex. However, a structural difference does not explain the positivity bias in the LPP (i.e. the amplitude for negative pictures should be also higher). In fact, fMRI research has shown greater reactivity in the visual cortex to erotic material in men suggesting a positivity bias (Sabatinelli et al., 2004).

Further concern is that the experimental paradigm of the present study was designed to investigate the incidental processing of task irrelevant emotional distracters. Although controversial, a small advantage in visual performance for men (Linn & Petersen, 1985) could explain increased incidental processing of emotional content. However, this does not explain the positivity bias in the LPP (i.e. the amplitude for negative pictures should be also higher), thus, the results suggest a positivity bias for men that cannot be explained by an advantage in visual-spatial ability. Lastly, generalizing the results to a wider population might be problematic because the sample in the present study consisted mainly of university students in introductory courses in psychology. Because if cultural differences (Brody, 1997) may shape neuronal mechanisms and emotional reactivity (Domes et al., 2010; Whittle et al., 2011; Stevens & Hamann, 2012). Because of this, the present sample might be problematic because of the very culturally narrow sample (i.e. mostly young, educated, middle class) in the present study (Henrich, Heine & Norenzayan, 2010). However, this is a problem the whole field of psychology is struggling with, resulting in that results should be interpreted cautiously.

Thus, any study on emotion needs to consider whether gender may have a potentially confounding effect if this variable is uncontrolled. To extend the obtained results, future studies should consider a wider sample than introductory psychology students. Further, research needs to resolve the actual mechanism for effects of gender. On one hand, gender per se may not cause these differences but may be a marker for other individual differences (e.g., in emotion regulation and personality) (Whittle et al., 2011). On the other hand, the ultimate causes of these gender differences may be biological influences (e.g., genetic, hormonal) and environmental influences (e.g., social, cultural) or a combination of both, but their different contributions have not yet been proven (Stevens & Hamann, 2012).
To conclude, valence effects on the LPP for emotional pictures were moderated by gender. Men showed a positivity bias for the LPP, and although women did not show a clear valence bias for the LPP, they showed a negativity bias on picture ratings. Notably, the gender differences for the LPP were obtained even for pictures that were repeated 20 times. Because previous studies with other measures suggest a positivity bias for men and a negativity bias for women, the present findings extend these studies suggesting that attention allocation for emotional pictures of different valence is similarly moderated by gender. Furthermore, because the LPP habituated more strongly for positive pictures than for negative pictures, a negativity bias may be present during habituation.
References


