Emotion
2012, Vol. 12, No. 6, 1362–1366

1528-3542/12/$12.00 DOI: 10.1037/a0028415

Beyond Attentional Bias: A Perceptual Bias in a Dot-Probe Task

Bruno R. Bocanegra, Jorg Huijding, and René Zeelenberg
Erasmus University Rotterdam

Previous dot-probe studies indicate that threat-related face cues induce a bias in spatial attention. Independently of spatial attention, a recent psychophysical study suggests that a bilateral fearful face cue improves low spatial-frequency perception (LSF) and impairs high spatial-frequency perception (HSF). Here, we combine these separate lines of research within a single dot-probe paradigm. We found that a bilateral fearful face cue, compared with a bilateral neutral face cue, speeded up responses to LSF targets and slowed down responses to HSF targets. This finding is important, as it shows that emotional cues in dot-probe tasks not only bias *where* information is preferentially processed (i.e., an attentional bias in spatial location), but also bias *what* type of information is preferentially processed (i.e., a perceptual bias in spatial frequency).

Keywords: emotion, anxiety, attentional bias, perceptual bias, spatial frequency

Previous dot-probe studies have shown that threat-related face cues (e.g., fearful and angry faces) induce a bias in spatial attention, in that participants respond more quickly to subsequent targets when the locations of the emotional face cues match target locations, compared with when they mismatch (Bradley et al., 1997; Carlson & Reinke, 2008; Holmes, Green, & Vuilleumier, 2005). Also, it has been shown that this bias is strongest for participants who report high levels of anxiety (Fox, 2002; Mogg & Bradley, 1999). Presumably, attentional biases reflect a functional mechanism where fast and automatic attention allocation to emotional information can aid people in threatening situations (LeDoux, 1995), but can go awry in psychopathology (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007).

Interestingly, recent psychophysical studies suggest that fearful face cues can also influence performance to subsequent targets independently of spatial attention (Bocanegra & Zeelenberg, 2009; Phelps, Ling, & Carrasco, 2006). More specifically, Bocanegra and Zeelenberg (2009) showed that a bilateral fearful face cue, compared with a bilateral neutral face cue, improved the perception of low spatial frequencies (LSFs), but impaired the perception of high spatial frequencies (HSFs). This indicates that the perceptual benefits of emotion do not extend to all basic dimensions of vision (also see Bocanegra & Zeelenberg, 2011). Instead of a general facilitation, emotion improves the processing of coarse features but impairs the processing of fine-grained details.

This article was published Online First May 28, 2012.

Bruno R. Bocanegra, Jorg Huijding, and René Zeelenberg, Department of Psychology, Erasmus University Rotterdam, Rotterdam, the Netherlands.

We thank Jurriaan Bos and Lévi van der Mee for testing the participants. This research was supported by a grant from the Netherlands Organization for Scientific Research (NWO) to René Zeelenberg.

Correspondence concerning this article should be addressed to Bruno R. Bocanegra, Department of Psychology, Erasmus University Rotterdam, Woudestein, T13-26, P.O. Box 1738, 3000 DR Rotterdam, the Netherlands. E-mail: bocanegra@fsw.eur.nl

This novel finding suggests that emotion induces a bias in visual perception. By a perceptual bias, we mean that the processing of some basic visual feature is enhanced at the expense of another basic feature. Although different from an attentional bias, a perceptual bias also has the potential of being a functionally adaptive mechanism. It has been suggested that emotion might temporarily facilitate faster, coarser visual pathways and inhibit slower, fine-grained visual pathways, in order to aid precisely those visual features that are most relevant in threatening situations, such as motion, depth, direction, and global configuration (Bocanegra & Zeelenberg, 2011). Taken together, this suggests that emotional cues may not only induce an attentional bias in spatial location, but may also induce a perceptual bias in spatial frequency.

In the Bocanegra and Zeelenberg (2009) study, visual performance was tested with near-threshold targets presented for 40 ms, which is not directly comparable to previous dot-probe tasks that measured RTs to suprathreshold targets that were presented until response. Also, Bocanegra and Zeelenberg used symmetrical cues (i.e., both fearful or both neutral) that were presented *adjacent* to the possible target locations, whereas dot-probe studies use asymmetrical cues (i.e., an emotional face paired with a neutral face) that are presented at the exact target locations. These substantial differences are due to the fact that dot-probe studies are concerned with the effect of emotional-cue location on response speed, whereas Bocanegra and Zeelenberg (2009) were interested in the effect of cue emotionality on perceptual accuracy (independently of location). In the present study, we combine these separate lines of research within a single experiment to answer the following novel questions.

Does the presentation of a fearful face cue, compared with a neutral face cue, induce a perceptual bias in a dot-probe task? If this is the case, this finding would merge these different research fields and show that emotional cues in dot-probe tasks not only influence *where* information is preferentially processed, but also *what* type of information is preferentially processed.

Does the classic attentional-bias effect vary as a function of the perceptual content of the target stimulus? A previous finding suggests that emotional cues have a diametrically opposite effect on performance, depending on the spatial frequency of the target (Bocanegra & Zeelenberg, 2009). If the attentional bias behaves similarly, this could have important practical implications for future dot-probe research in terms of what targets are optimal for obtaining the effect.

Given that emotion-induced attentional biases have been linked to anxiety (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007), another question that emerges is whether an emotion-induced perceptual bias is also enhanced in anxious individuals. Considering that emotion identification in faces is crucial for social functioning, and that emotion/spatial-frequency interactions are often found for facial stimuli (Bocanegra & Zeelenberg, 2009, 2011; Pourtois, Dan, Grandjean, Sander, & Vuilleumier, 2005; Vuilleumier, Armony, Driver, & Dolan, 2003), we investigated whether a perceptual bias in spatial frequency would be related to social dimensions of anxiety.

Various (subclinical) psychopathologies have been related to biases in spatial attention, temporal attention, memory, semantics, evaluation, attribution, reasoning, and decision making (Arntz, Rauner, & Van den Hout, 1995; Fox, Russo, & Georgiou, 2005; MacLeod, Mathews, & Tata, 1986; Maner et al., 2007; McNally, Foa, & Donnell, 1989). To our knowledge, no previous study has demonstrated a perceptual bias in a basic visual dimension that is related to anxiety. An anxiety-related bias in spatial frequency processing would comprise the first low-level perceptual bias in subclinical psychopathology.

To answer these research questions, we used a variant of the dot-probe paradigm in which we varied the spatial-frequency content of the target stimuli, creating high spatial-frequency and low spatial-frequency targets. We manipulated emotion with fearful and neutral face cues. In addition to the asymmetrical cues (a fearful face paired with a neutral face, where the fearful face either matches or mismatches the target location), we also included symmetrical cues where both faces in the cue were either fearful or neutral.[1] In order to investigate the effect of anxiety on the attentional and perceptual biases, we collected self-report measures of general and social anxiety.

Method

Participants

Thirty-five participants (17 men and 18 women, with a mean age of 21.9 years) with normal or corrected-to-normal vision participated in the experiment. All participants were students at Erasmus University Rotterdam, the Netherlands, participating for course credit.

Apparatus

Visual stimuli were generated using MATLAB (Natick, MA) and the Psychophysics Toolbox (Brainard, 1997), and were presented on a gamma-corrected Iiyama 21-inch (100-Hz refresh rate; 1280 × 1024 pixels; Oude Meer, the Netherlands). A video attenuator was used to drive just the green gun of the monitor.

Stimuli. A light gray fixation cross (0.8° × 0.8°, 12 cd/m^2) was presented at the center of a uniform background (5 cd/m^2) for 800 ms prior to the stimulus sequence (see Figure 1). Cue displays consisted of two face stimuli (each 7° in diameter), both presented at 8° eccentricity to the left and right of fixation. Target displays contained a single Gabor patch (3° sinusoidal grating enveloped by a Gaussian), randomly presented either to the left or to the right of fixation at 8° eccentricity. Gabor patches (80% Michelson luminance contrast) were constructed using an LSF, 1 cycle-per-degree (cpd) or HSF, 4 cpd) wavelength, and were rotated 20° clockwise or counterclockwise. The spatial frequencies of the Gabor targets were justified by previous research showing differential emotional effects in these spatial-frequency ranges (Vuilleumier et al., 2003; Bocanegra & Zeelenberg, 2009). To manipulate emotion, we selected a set of facial photographs of 11 unique persons portraying prototypical fearful and neutral expressions from the Picture of Facial Affect Series (Ekman & Friesen, 1976). Cue displays consisted of a pair of facial cut-outs of the same person, that were either both fearful, both neutral or consisted of a fearful face paired with a neutral face. The average pixel intensity on a 256-point. gray-level scale did not differ for the fearful versus the neutral faces (186.23 vs. 187.70; $t(10) = 0.76$, $p > .20$). Furthermore, we low-pass filtered (< 2.5 cpd) and high-pass filtered (> 2.5 cpd) the face stimuli in order to test whether the average pixel intensity differed in the ranges specifically coinciding with the LSF (1 cpd) and HSF (4 cpd) Gabor targets (Schyns & Oliva, 1999). Again, we found no differences between the fearful and neutral faces in the low-pass range (171.64 vs. 172.01; $t(10) = 0.07$, $p > .20$) and in the high-pass range (128.27 vs. 128.21; $t(10) = 1.31$, $p > .20$). The experiment was conducted in a dark (1–2 lux) and quiet room.

Questionnaires. Prior to the experimental session, participants filled out Dutch versions of the State–Trait Anxiety Inventory (Cronbach's alpha's > .92; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1970), the Social Interaction Anxiety Scale, and the Social Phobia Scale (Cronbach's alpha's > .85; Mattick & Clarke, 1998). Two participants failed to complete the State–Trait Anxiety Inventory, and one participant failed to complete the Social Interaction Anxiety Scale.

Procedure

Participants viewed the display binocularly at a distance of 57 cm, with their heads stabilized by a chin rest. They were asked to fixate on the central fixation point throughout testing. All experimental conditions were equiprobable and presented in a randomized order within each block. Participants performed a speeded orientation-detection task on the target (both speed and accuracy were stressed). If the target was tilted clockwise, they pressed the "m" key on the keyboard; if the target was tilted counterclockwise, they pressed the "z" key. Each participant performed 20 training trials prior to the main experiment. The experiment consisted of two blocks of 352 trials each. All variables varied randomly from trial to trial.

Data analysis. Incorrect responses were excluded from the analysis (< 6% in all conditions). Mean RTs were calculated for correct responses, removing trials with RTs of fewer than 200 ms or more than 2000 ms (<3% of correct trials). Separate repeated-measures analyses of variance were conducted for the symmetrical

[1] For the asymmetrical cues, we reasoned that the distribution of limited attentional resources across the two locations would be biased toward the fearful face location. However, for the symmetrical cues, we reasoned that the net distribution of limited attentional resources would be equal across the two locations, and thus would allow the perceptual bias to become manifest.

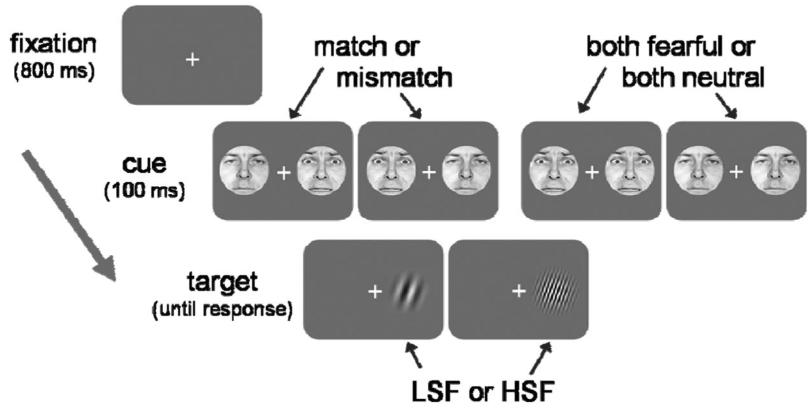

Figure 1. Illustration of the general trial sequence. See text for details.

cues (cue type: fearful vs. neutral, target type: LSF vs. HSF), and for the asymmetrical cues (cue type: match vs. mismatch, target type: LSF vs. HSF).

Results

The left panel in Figure 2 shows RTs as a function of cue type and target spatial frequency for the asymmetrical cues. We found a significant main effect of cue type, $F(1, 34) = 9.20$, $p < .01$, $\eta_p^2 = 0.21$. Participants responded 12 ms faster when the location of the fearful cue matched that of the target, compared with when the location of the fearful cue and target mismatched. We failed to find an interaction between cue type and target spatial frequency, $F(1, 34) < 1$, $p > .79$, indicating that the effect of match versus mismatch cues was the same for LSF and HSF targets. Planned comparisons using the pooled-variance estimate of the two main effects and interaction (Loftus & Masson, 1994) indicated that the speed-up for match cues was significant for both LSF and HSF targets, $t(34) = 3.29$, $p < .01$, Cohen's $d = .56$ and $t(34) = 2.66$, $p < .02$; Cohen's $d = .45$, respectively. These results indicate that the attentional bias effect is not modulated by the spatial-frequency content of the target.

For the symmetrical cues, in contrast, we did observe a significant interaction between cue type and target spatial frequency, $F(1, 34) = 6.91$, $p < .02$, $\eta_p^2 = 0.17$, indicating that the effect of fearful versus neutral cues differed for LSF and HSF targets (see the right panel in Figure 2). Planned comparisons (Loftus & Masson, 1994) indicated that fearful cues speeded up responding to LSF targets, $t(34) = 2.99$, $p < .01$, Cohen's $d = .51$, and slowed down responding to HSF targets, $t(34) = 2.27$, $p < .03$, Cohen's $d = .38$. These results indicate that the perceptual-bias effect is modulated by the spatial-frequency content of the target.

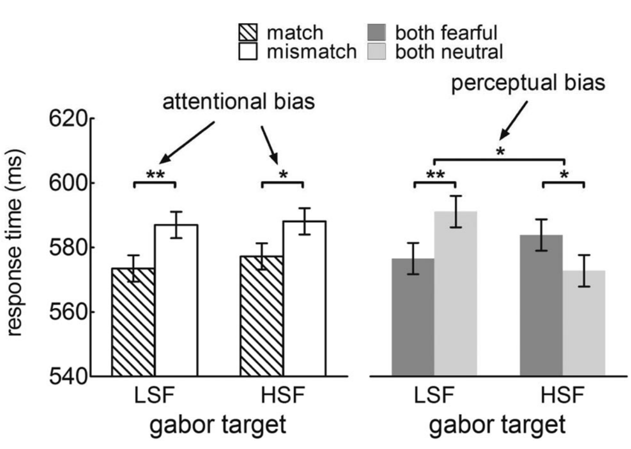

Figure 2. Response times (RTs) for the experimental conditions. Error bars reflect the pooled within-subject standard errors (Loftus & Masson, 1994). Pair-wise comparisons are based on the 95% confidenc-interval of the pooled within-subject standard errors; $^{*}p < .05$. $^{**}p < .01$.

Correlation Analyses

To examine whether individual differences in anxiety were related to the two emotion-induced biases observed in our experiment, we calculated separate attentional-bias and perceptual-bias measures for each individual participant and correlated these with the anxiety measures (see Table 1). Attentional bias was calculated as $(RT_{(mismatch,HSF)} - RT_{(match,HSF)}) + (RT_{(mismatch,LSF)} - RT_{(mismatch,LSF)})/2$, and perceptual bias was calculated as $(RT_{(both\ fearful,HSF)} - RT_{(both\ neutral,HSF)}) -$

Table 1
Bivariate Correlations Between Attentional Bias, Perceptual Bias, and Anxiety Questionnaires

	1	2	3	4	5	6
1. Attentional bias	—					
2. Perceptual bias	.20	—				
3. State anxiety	.06	.09	—			
4. Trait anxiety	.54**	.25	.15	—		
5. Social interaction	.38*	.12	.16	.52**	—	
6. Social phobia	.38*	.42*	.17	.44**	.57**	—
M	12	26	1.76	1.81	0.88	0.64
SD	24	58	0.99	0.45	0.55	0.41
N	35	35	33	35	34	35

Note. Differences in sample sizes were due to three participants that failed to complete the respective questionnaire.
$^{*}p < .05$. $^{**}p < .01$.

($RT_{(both\ fearful,LSF)} - RT_{(both\ neutral,LSF)}$). The attentional bias correlated significantly with trait anxiety, $r(33) = .54$, $p < .01$, social-interaction anxiety, $r(31) = .38$, $p < .05$, and social phobia, $r(33) = .38$, $p < .05$, whereas the perceptual bias correlated only with social phobia, $r(33) = .42$, $p < .02$. Also, the attentional and perceptual biases themselves did not correlate with each other ($p > .24$).

We ran follow-up *t* tests after median splits on the anxiety measures to assess whether the attentional and perceptual biases were present or absent in the low-anxiety groups. The attentional bias was only significant for participants scoring high on trait anxiety: $t(16) = 3.33$, $p < .01$, Cohen's $d = .81$, social-interaction anxiety: $t(16) = 3.09$, $p < .01$, and social phobia: $t(16) = 2.42$, $p < .03$, Cohen's $d = .59$. (See left three graphs in Figure 3.) In addition, we observed that the perceptual bias was only significant for participants scoring high on social phobia $t(16) = 3.24$, $p < .01$, Cohen's $d = .79$. (See right graph in Figure 3.)

Discussion

For the asymmetrical cues, we found a classic attentional-bias effect, where responses to targets were faster for match cues than for mismatch cues. Of importance: The attentional bias effect was not different for LSF and HSF targets. Consistent with previous findings, we observed that the attentional bias varied as a function of participants' trait anxiety, social-interaction anxiety, and social phobia (Bar-Haim et al., 2007).

For the symmetrical cues, we found that fearful-face cues, compared with neutral face cues, speeded up responses to LSF targets and slowed down responses to HSF targets. This interaction indicates that emotional cues induce a perceptual bias in a dot-probe task, in which emotion speeds up the processing of coarse features and slows down the processing of fine-grained details. It is important to point out here that this is the first indication that emotion-induced trade offs in spatial frequency can be obtained in an R-T task in which the target is clearly visible (i.e., not impoverished). Furthermore, we found that this perceptual bias in spatial frequency varied as a function of participants' social phobias, where the perceptual bias was only observed for participants who scored above the median on social phobia. It appears that the perceptual bias in spatial frequency may be specifically related to social phobia, whereas the attentional bias in spatial location is more general and relates to different types of anxiety.

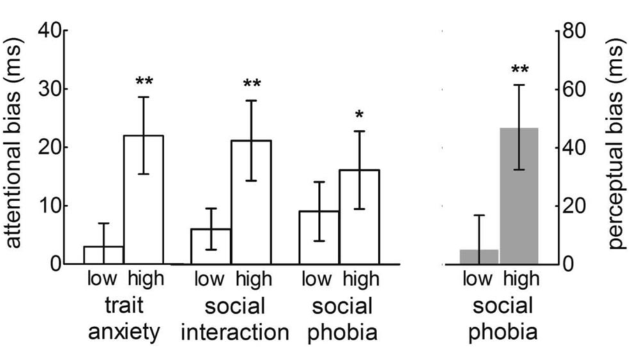

Figure 3. Attentional bias for participants with low and high trait anxiety, social interaction anxiety, social phobia, and perceptual bias for participants with low and high social phobia. See text for details on the calculation of attentional and perceptual biases. Error bars indicate standard errors of the mean; $^{*} p < .05$. $^{**} p < .01$.

Of interest: Two recent studies corroborate a possible link between spatial-frequency processing and psychopathology that is related to social functioning. For example, highly socially anxious individuals rely more on LSF information when identifying anger in faces (Langner, Becker, & Rinck, 2009). Also, Asperger syndrome is associated with specific impairments in identifying LSF facial emotions (Kätsyri, Saalasti, Tiippana, von Wendt, & Sams, 2008). An interesting question that arises is whether a hypo- versus hypersensitivity to emotional faces is associated with different perceptual biases in the spatial-frequency domain, and what the causal direction of this association is.

Although it has been shown that emotional cues have a diametrically opposite effect on visual performance, depending on target spatial frequency (Bocanegra & Zeelenberg, 2009; also see Bocanegra & Zeelenberg, 2011), we found that the attentional bias did not depend on target spatial frequency. It is important to note, this suggests that the perceptual content of the target is not critical for obtaining an attentional bias: Emotion-induced modulations in spatial attention occur independently of spatial-frequency processing. Also of interest: Bocanegra and Zeelenberg (2009) found that the interaction between cue emotionality and target spatial frequency did not depend on the spatial location of the emotional face: Similar effects were found when the fearful face was presented in the same or contralateral visual hemifield.[2] In all, the absence of a spatial-frequency modulation of the attentional bias in the present study, as well as the absence of a spatial-location modulation of the perceptual bias in Bocanegra and Zeelenberg (2009), suggest that the emotion-induced perceptual bias in spatial frequency does not depend on the allocation of spatial attention.

Accumulating evidence suggests that the amygdala, a medial-temporal-lobe structure involved in emotion processing, is a critical mediator of the emotional modulations in both attention and perception (LeDoux, 1995). Emotional stimuli may quickly and automatically activate the amygdala, which in turn may directly modulate processing in the ventral–visual stream (Vuilleumier, 2005). Previous findings have shown that the processing of threat value is mediated predominantly by LSFs in the stimulus (Bayle, Henaff, & Krolak-Slamon, 2009; Mermillod, Droit-Volet, Devaux, Schaefer, & Vermeulen, 2010). It has been suggested that the amygdala may receive visual input from the magnocellular pathway, which is selectively tuned to LSFs (Vuilleumier et al., 2003), and that this boost in magnocellular processing may selectively inhibit parvocellular processing of HSFs (Bocanegra & Zeelenberg, 2009).

Conceptually, the perceptual bias uncovered in this study may help in theorizing the mechanisms underlying emotional-processing biases related to anxiety. Although over the past years the field has become acquainted with the mechanisms underlying attentional biases, such as engagement, shift, and disengagement (Fox, Russo, Bowles, & Dutton, 2001), the current study shows

[2] It is possible that no attentional effect was found by Bocanegra and Zeelenberg (2009) because the cues were presented adjacent to the target locations instead of at the exact target locations (which was the case in the present study).

that emotional-processing biases extend all the way into the perceptual domain. Our study adds to previous findings (Holmes et al., 2005; Bocanegra & Zeelenberg, 2009) by demonstrating that emotion-induced processing biases do not always depend on the allocation of spatial attention: One can obtain biases in dot-probe tasks that are perceptual in nature. Also, our study provides the first indication that individual differences in anxiety may modulate inhibitory interactions between low-level spatial-frequency filters in our visual system, and suggests that future studies should explore other interactions between anxiety and low-level vision. In sum, our study shows that emotional cues in dot-probe tasks not only bias *where* information is preferentially processed (attentional bias in spatial location), but also bias *what* type of information is preferentially processed (perceptual bias in spatial frequency).

References

Arntz, A., Rauner, M., & Van den Hout, M. (1995). "If I feel anxious, there must be danger": Ex-consequentia reasoning in inferring danger in anxiety disorders. *Behaviour Research and Therapy, 33,* 917–925. doi:10.1016/0005-7967(95)00032-S

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133,* 1–24. doi:10.1037/0033-2909.133.1.1

Bayle, D. J., Henaff M-A., & Krolak-Salmon, P. (2009). Unconsciously perceived fear in peripheral vision alerts the limbic system: A MEG study. *PLoS ONE, 4,* e8207. doi:10.1371/journal.pone.0008207

Bocanegra, B. R., & Zeelenberg, R. (2009). Emotion improves and impairs early vision. *Psychological Science, 20,* 707–713. doi:10.1111/j.1467-9280.2009.02354.x

Bocanegra, B. R., & Zeelenberg, R. (2011). Emotion-induced trade-offs in spatiotemporal vision. *Journal of Experimental Psychology: General, 140,* 272–282. doi:10.1037/a0023188

Bradley, B., Mogg, K., Millar, N., Bonham-Carter, C., Fergusson, E., Jenkins, J., & Parr, M. (1997). Attentional biases for emotional faces. *Cognition and Emotion, 11,* 25–42. doi:10.1080/026999397380014

Brainard, D. H. (1997). The Psychophysics toolbox. *Spatial Vision, 10,* 433–436. doi:10.1163/156856897X00357

Carlson, J. M., & Reinke, K. S. (2008). Masked fearful faces modulate the orienting of covert spatial attention. *Emotion, 8,* 522–529. doi:10.1037/a0012653

Ekman, P., & Friesen, W. V. (1976). *Pictures of facial affect.* Palo Alto, CA: Consulting Psychologists Press.

Fox, E. (2002). Processing emotional facial expressions: The role of anxiety and awareness. *Cognitive, Affective & Behavioral Neuroscience, 2,* 52–63. doi:10.3758/CABN.2.1.52

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130,* 681–700. doi:10.1037/0096-3445.130.4.681

Fox, E., Russo, R., & Georgiou, G. A. (2005). Anxiety modulates the degree of attentive resources required to process emotional faces. *Cognitive, Affective & Behavioral Neuroscience, 5,* 396–404. doi:10.3758/CABN.5.4.396

Holmes, A., Green, S., & Vuilleumier, P. (2005). The involvement of distinct visual channels in rapid attention towards fearful facial expressions. *Cognition & Emotion, 19,* 899–922. doi:10.1080/02699930441000454

Kätsyri, J., Saalasti, S., Tiippana, K., von Wendt, L., & Sams, M. (2008). Impaired recognition of facial emotions from low-spatial frequencies in Asperger syndrome. *Neuropsychologia, 46,* 1888–1897. doi:10.1016/j.neuropsychologia.2008.01.005

Langner, O., Becker, E. S., & Rinck, M. (2009). Social anxiety and anger identification: Bubbles reveal differential use of facial information with low spatial frequencies. *Psychological Science, 20,* 666–670. doi:10.1111/j.1467-9280.2009.02357.x

LeDoux, J. E. (1995). Emotion: Clues from the brain. *Annual Review of Psychology, 46,* 209–235. doi:10.1146/annurev.ps.46.020195.001233

Loftus, G. R., & Masson, M. J. (1994). Using confidence intervals in within-subject designs. *Psychonomic Bulletin and Review, 1,* 476–490.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95,* 15–20. doi:10.1037/0021-843X.95.1.15

Maner, J., Richey, J., Cromer, K., Mallott, M., Lejuez, C., Joiner, T., & Schmidt, N. (2007). Dispositional anxiety and risk-avoidant decision-making. *Personality and Individual Differences, 42,* 665–675. doi:10.1016/j.paid.2006.08.016

Mattick, R. P., & Clarke, J. C. (1998). Development and validation of measures of social phobia scrutiny fear and social interaction anxiety. *Behaviour Research and Therapy, 36*(4), 455–470. doi:10.1016/S0005-7967(97)10031-6

McNally, R., Foa, E., & Donnell, C. (1989). Memory bias for anxiety information in patients with panic disorder. *Cognition and Emotion, 3,* 27–44. doi:10.1080/02699938908415234

Mermillod, M., Droit-Volet, S., Devaux, D., Schaefer, A., & Vermeulen, N. (2010). Are coarse scales sufficient for fast detection of visual threat? *Psychological Science, 21,* 1429–1437. doi:10.1177/0956797610381503

Mogg, K., & Bradley, B. (1999). Orienting of attention to threatening facial expressions presented under conditions of restricted awareness. *Cognition and Emotion, 13,* 713–740. doi:10.1080/026999399379050

Phelps, E. A., Ling, S., & Carrasco, M. (2006). Emotion facilitates perception and potentiates the perceptual benefits of attention. *Psychological Science, 17,* 292–299. doi:10.1111/j.1467-9280.2006.01701.x

Pourtois, G., Dan, E. S., Grandjean, D., Sander, D., & Vuilleumier, P. (2005). Enhanced extrastriate visual response to bandpass spatial frequency filtered fearful faces: Time course and topographic evoked-potentials mapping. *Human Brain Mapping, 26,* 65–79. doi:10.1002/hbm.20130

Schyns, P. G., & Oliva, A. (1999). Dr. Angry and Mr. Smile: When categorization flexibly modifies the perception of faces in rapid visual presentations. *Cognition, 69,* 243–265. doi:10.1016/S0010-0277(98)00069-9

Spielberger, C. D., Gorsuch, R. L., Lushene, R. E., Vagg, P. R., & Jacobs, G. A. (1970). *Manual for the State-Trait Anxiety Inventory.* Palo Alto, CA: Consulting Psychologists Press.

Vuilleumier, P. (2005). How brains beware: Neural mechanisms of emotional attention. *Trends in Cognitive Sciences, 9,* 585–594. doi:10.1016/j.tics.2005.10.011

Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. *Nature Neuroscience, 6,* 624–631. doi:10.1038/nn1057

Received November 8, 2011
Revision received February 2, 2012
Accepted March 7, 2012 ■