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Emotional and neutral scenes in competition: Orienting, efficiency, and identification

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Short article

Emotional and neutral scenes in competition: Orienting, efficiency, and identification

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To investigate preferential processing of emotional scenes competing for limited attentional resources with neutral scenes, prime pictures were presented briefly (450 ms), peripherally (5.2° away from fixation), and simultaneously (one emotional and one neutral scene) versus singly. Primes were followed by a mask and a probe for recognition. Hit rate was higher for emotional than for neutral scenes in the dual- but not in the single-prime condition, and A' sensitivity decreased for neutral but not for emotional scenes in the dual-prime condition. This preferential processing involved both selective orienting and efficient encoding, as revealed, respectively, by a higher probability of first fixation on—and shorter saccade latencies to—emotional scenes and by shorter fixation time needed to accurately identify emotional scenes, in comparison with neutral scenes.

Due to their adaptive relevance, emotional stimuli are expected to be detected quickly. There is evidence of fast emotional processing of pictorial stimuli when they are presented very briefly and masked (Dimberg, Thunberg, & Elmehed, 2000; Hermans, Spruyt, De Houwer, & Eelen, 2003). Additionally, ERP (event-related potential) studies have shown early (70–120 ms following stimulus onset) electrophysiological differentiation between neutral and fearful faces (Pourtois, Thut, Grave de Peralta, Michel, & Vuilleumier, 2005), or unpleasant and pleasant versus neutral scenes (Keil et al., 2001).

As emotional and neutral stimuli were typically presented one at a time in these studies, this approach indicates how stimuli are encoded when they are presented separately. However, on most occasions, the capacity-limited cognitive system must select which objects in the environment are given processing priority. Thus, the

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relative accessibility of emotional over neutral stimuli can be explored by presenting them concurrently. In such a situation they compete for access to attention and object identification. One way to cope with attentional-capacity limitations and to adjust to the environmental demands requiring stimulus identification would involve selective orienting; another would involve reduced consumption of attentional resources to render stimulus processing maximally efficient.

The aim of the current study is to investigate the preferential processing of emotional scenes presented concurrently with neutral scenes. More specifically, our purpose is to examine three aspects of preferential processing: (a) whether it involves the construction of a more accurate representation for emotional than neutral scene content; (b) whether this is accomplished by means of a prioritization mechanism involving selective attentional orienting towards the emotional stimulus; and/or (c) whether it is performed through an efficient encoding mechanism involving reduced resource consumption during the analysis of emotional scene content.

Prior research on the processing of concurrent emotional and neutral scenes has addressed these issues to some extent. In the visual search task, a discrepant (emotional or neutral) target must be detected among an array of distractors (neutral or emotional). Faces depicting emotional expressions (Fox et al., 2000; Juth, Lundqvist, Karlsson, & Öhman, 2005) and unpleasant visual objects (snakes, guns, etc.; Blanchette, 2006; Öhman, Flykt, & Esteves, 2001) have been presented as stimuli. Detection times are faster when the target has some emotional value than when it is neutral. In the dot-probe paradigm (Mogg, Bradley, Miles, & Dixon, 2004), an emotional and a neutral picture are presented concurrently and briefly and are subsequently replaced by a visual target (dot). The target is detected faster (at least by high-anxiety individuals) when it replaces an emotional picture than when it replaces a neutral picture. These findings suggest that when competing for attentional resources, emotional stimuli are given priority. Nevertheless, the visual search and dot-probe tasks cannot determine whether such priority involves facilitated initial orienting or later attentional engagement (or processing efficiency).

Alternative paradigms have been employed to investigate the issue of selective orienting and efficiency in the preferential processing of emotional versus neutral scenes competing for processing resources. The studies of Calvo and Lang (2004) and Nummenmaa, Hyönä, and Calvo (2006) examined selective orienting. One emotional and one neutral scene were presented simultaneously for 3 s either parafoveally or peripherally. Participants were instructed to respond whether the scenes were of the same valence or not. Calvo and Lang (2004) found that the probability of first fixation and the viewing time during the first 500 ms were greater for both pleasant and unpleasant scenes than for neutral scenes. These findings were replicated by Nummenmaa et al. (2006), who also found that emotional pictures were more likely to be fixated first and gazed at longer during the first 600–700 ms (but not later) even when participants were instructed to avoid looking at the emotional pictures. This was interpreted as an early involuntary attention capture by emotional content. Calvo and Lang (2005) examined the quality of the representation obtained for simultaneously presented emotional and neutral scenes. Pairs of neutral–emotional prime scenes were presented parafoveally for 150, 300, 450, or 900 ms, followed by a mask and a probe scene, to which the participants responded whether it depicted the same content as one of the primes. The probe was either identical in content to either of the primes (but physically different, in size, colour, and spatial orientation), or related in semantic content. Detection sensitivity was generally higher for both pleasant and unpleasant scenes than for neutral scenes. This suggests that the content of emotional scenes was processed more accurately than that of neutral scenes.

In sum, the results of Calvo and Lang (2005) showed enhanced accuracy in the representation of the semantic content of emotional scenes; those of Calvo and Lang (2004) and Nummenmaa et al. (2006) suggest that this enhanced accuracy could be due to selective initial orienting to the emotional stimuli. This orienting hypothesis is reasonable if we take into account that recognition accuracy in the Calvo and Lang (2005) experiments was equivalent for emotional and neutral scenes only in the 900-ms display condition (i.e., when there was enough time to look at both pictures in the pair) and in a single-stimulus condition (i.e., when all attention could be allocated to each stimulus separately). However, there is an alternative hypothesis that can account for the superior recognition of emotional scenes: It is possible that once fixated (i.e., after rather than before fixation) the emotional content is processed more efficiently than the neutral content, such that the former needs fewer resources to be identified than does the latter. In neither of the previous studies was this encoding efficiency hypothesis investigated. In the current study we explored it using a paradigm that combined the selective orienting (Nummenmaa et al., 2006) and the cognitive representation (Calvo & Lang, 2005) approaches.

To assess the representation obtained from visual scenes, we presented pairs of neutral and emotional (unpleasant or pleasant) prime pictures for 450 ms in peripheral vision (5.2° away from a central fixation point), followed by a 500-ms mask and a probe for recognition. The probe was either identical or related in content to the prime. Accurate identification of a prime would lead to correct discrimination between the identical and the related probe. A control condition involving a single prime was compared with the dual-prime condition, to establish the effect of resource competition. If there is preferential processing of emotional scenes, identification of them will be better than that of neutral scenes in the dual-prime condition but not in the single-prime condition, and identification will improve from the dual- to the single-prime condition for neutral scenes to a greater extent than for emotional scenes.

In addition, to assess prioritization in attentional orienting, we monitored eye movements towards the prime stimuli. The probability of first fixating one of the scenes and the latency of the initial saccade towards a scene were used as measures of early selective orienting. Finally, encoding efficiency was estimated by dividing the recognition sensitivity score by gaze duration on each prime stimulus. If emotional scenes are processed more efficiently than neutral scenes, then the former will take less time to be encoded than the latter, to reach equivalent recognition accuracy, as reflected by shorter gaze duration. It must be noted that efficiency involves more than just speed. It indexes the relationship between performance (i.e., accurate recognition) and the invested attentional resources (i.e., fixation time) to attain a given performance level. A more efficient process will involve higher recognition accuracy (A')/gaze duration ratio.

Method

Participants

A total of 48 psychology students (24 females) participated for course credit (mean age 21.7 years). Half of them (12 females; 12 males) were assigned to either the single- or the dual-prime condition.

Stimuli

We used 128 digitized photographs from the International Affective Picture System (IAPS; Center for the Study of Emotion and Attention, 2005), of which 64 were of neutral affective valence, 32 were unpleasant, and 32 were pleasant (see Appendix A). All pictures depicted people, in a variety of nonemotional daily activities, or suffering threat or harm, or enjoying themselves. A total of 64 pictures (32 neutral; 16 unpleasant; 16 pleasant) were used as targets—that is, when the probe was identical in content to one of the two primes. Another 64 stimuli were used as matched pictures—that is, when the probe was related to one of the primes in topic and valence, but the people appearing in the photo and their specific actions were different. Thus, the target and the matched scenes were similar in general content and emotionality, but their specific content was different. For examples, see Calvo and Lang (2005) and Calvo (2006). The related probes served to assess the false alarm rate and discrimination sensitivity (A').

When presented as primes, all pictures appeared in their original colour. Each prime subtended a visual angle of 13.3º by 10.9º, at a 60-cm viewing distance. A central fixation point was located at 5.2° of visual angle, horizontally, from the inner edge of each prime picture. The probe pictures were in greyscale, they increased in size (35.8° by 26.9°), and their left–right orientation was mirror-reversed.

As low-level visual factors are important in attentional orienting, it is critical to match the saliency values of the objects being inspected, when effects of semantic factors are investigated (see Underwood & Foulsham, 2006). Using Adobe Photoshop, we computed colour saturation (red, green, and blue) values for each picture, and with Matlab (The Mathworks, Natick, MA) we calculated mean luminance, variance of luminance, root mean square (RMS) contrast, kurtosis, skewness, and energy. One-way (unpleasant vs. neutral vs. pleasant) analyses of variance (ANOVAs) showed no significant differences in any of these image characteristics (see mean scores in Table 1).

Apparatus

The pictures were presented on a 21″ monitor. In the dual-prime condition, participants' eye movements were recorded with an EyeLinkII eye-tracker (SR Research Ltd., Mississauga, Ontario, Canada) using a 500-Hz sampling rate, with a spatial accuracy better than 0.5°. Participants had their head positioned on a chin and forehead rest.

Table 1. *Mean scores of the stimulus characteristics of the emotional and the neutral stimuli*

	Type of scene		
Characteristic	*Unpleasant*	*Neutral*	*Pleasant*
Red saturation	111 (21)	114 (22)	125 (38)
Green saturation	90 (18)	91 (14)	92 (24)
Blue saturation	79 (16)	80 (24)	78 (32)
Luminance[a]	100 (14)	104 (16)	107 (20)
Luminance[b]	70 (11)	70 (12)	27 (13)
RMS contrast	0.70 (0.14)	0.67 (0.11)	0.69 (0.18)
Skewness	0.64 (0.39)	0.55 (0.53)	0.35 (0.63)
Kurtosis	2.44 (0.50)	2.52 (1.17)	2.36 (1.08)
Energy[c]	7.285 (3.189)	8.721 (2.722)	6.876 (1.829)

Note: Standard deviations in parentheses.
[a]Average. [b]Variance. [c]$\times 10^{-5}$.

Procedure

On each trial, following a central fixation circle, pairs of emotional and neutral prime pictures (dual-prime condition) or individual prime pictures (single-prime condition) were presented peripherally for 450 ms. Following the prime offset, a mask (a random combination of colours) was presented for 500 ms. Finally, a probe picture, either a target (identical) or a matched (related) picture, appeared centrally for recognition until the participant responded. The participant was to respond, by pressing a Yes or a No key, whether the probe—although different in colour, size, and orientation—had identical content (i.e., "the same people doing the same things") to that of one of the primes. After 12 practice trials, 128 experimental trials were presented in random order.

Design and measures

The design involved type of prime presentation (single vs. dual) as a between-subjects factor and emotional valence of probe (unpleasant vs. neutral vs. pleasant), prime–probe relationship (identical vs. related) and visual field of the prime (left vs. right) as within-subject factors. On target trials, the probe was identical in specific content to (one of) the prime(s), but different in colour, size, and left–right orientation. On catch trials, the probe was related in topic and affective valence to (one of) the prime(s), but different in form and specific content. Participants saw each picture as a prime twice in the left visual field and twice in the right field. Each prime preceded an identical probe and a related probe once.

Recognition and eye-movement measures (only in the dual-prime condition) were collected. *Recognition performance* was assessed by hit and false-alarm rates, sensitivity scores (A'), and reaction times for hits. The probability of hits (i.e., correct "yes" responses to identical probes) and false alarms (i.e., incorrect "yes" responses to related probes) were converted to the A' index of discrimination sensitivity (Snodgrass & Corwin, 1988). *Eye-movements* were analysed to yield: (a) the probability that one of the primes was fixated first; (b) saccade latency (i.e., the time to initiate an eye movement towards a prime); (c) gaze duration (i.e., the time spent fixating a picture before exiting it); and (d) number of fixations on each picture. Finally, an *encoding efficiency* index was computed by dividing sensitivity scores by gaze duration. This provides an estimate of the proportion of overt attentional resources invested to accurately identify a scene.

Results

Recognition performance

ANOVAs of 2 (prime presentation) × 3 (emotional valence) × 2 (visual field) were conducted on the recognition measures (see mean scores in Table 2). Bonferroni corrections for multiple contrasts were performed for both recognition and eye-movement measures. For *hit rate*, the main effect of valence, $F(2, 92) = 4.45$, $p < .025$, was qualified by a valence by prime presentation interaction, $F(2, 92) = 4.20$, $p < .025$, and a three-way interaction, $F(2, 92) = 6.79$, $p < .01$. In the single-prime condition, the analysis yielded no significant effects (all $ps \geq .41$). In the dual-prime condition, the probability of hits was affected by emotional valence, $F(2, 46) = 6.26$, $p < .01$, with a higher hit rate for both unpleasant and pleasant pictures than for neutral pictures (both $ps < .05$). This effect was modulated by the location of the prime, $F(1, 46) = 5.98$, $p < .01$, with more hits for unpleasant pictures in the left visual field (unpleasant = .855; neutral = .781; pleasant = .789), $t(23) = 2.85$, $p < .01$, and for pleasant pictures in the right field (unpleasant = .837; neutral = .776; pleasant = .907), $t(23) = 3.74$, $p < .001$. For *false alarms*, the only significant effect involved type of prime presentation, $F(1, 46) = 9.03$, $p < .01$, with a higher false-alarm rate in the dual- (.236) than in the single-prime (.141) condition. For *sensitivity A′* scores, there was a main effect of prime presentation, $F(1, 46) = 4.95$, $p < .05$, and a valence by presentation interaction, $F(2, 92) = 3.63$, $p < .05$. Post hoc contrasts revealed an increase in sensitivity from the dual to the single condition for neutral scenes, $t(46) = 3.85$, $p < .001$, but not for unpleasant or pleasant scenes (both $ts < 1$; see Figure 1). For *reaction times*, there was also a valence by type of prime presentation interaction, $F(2, 92) = 5.56$, $p < .01$. In the single-prime condition, no effects emerged. In the dual-prime condition, reaction times were affected by visual field, $F(1, 23) = 10.60$, $p < .01$. Response latencies were longer for stimuli presented in the left (948 ms) than in the right visual field (897 ms).

Table 2. *Mean probability of hits, false alarms, and reaction times for hits, as a function of emotional valence of scenes, in the single-prime and dual-prime conditions*

Condition	*Valence*	*Hits*	*FAs*	*RT LVF*	*RT RVF*
Single-prime	Unpleasant	.822	.160	934	914
	Neutral	.815	.125	926	870
	Pleasant	.811	.137	935	913
Dual-prime	Unpleasant	.846[a]	.247	917	896
	Neutral	.779[b]	.246	998	934
	Pleasant	.848[a]	.216	929	860

Note: FAs = false alarms. RT = reaction time. LVF = hits in the left visual field. RVF = hits in the right visual field.
[a,b]A different superscript indicates significant differences between valence categories.

Eye-movement and encoding efficiency data

For each dependent variable, a 3 (emotional valence) × 2 (visual field) ANOVA was conducted (see mean scores in Table 3). An effect of valence emerged on the *probability of first fixation*, $F(2, 46) = 17.56$, $p < .0001$. Participants were more likely to look first to the unpleasant and the pleasant picture than to the neutral picture (both $ps < .001$). For *saccade latency*, there was also an effect of valence, $F(2, 46) = 17.56$, $p < .0001$. Latencies were shorter for saccades initiated towards the unpleasant and the pleasant pictures than towards the neutral pictures (both $ps < .025$). The analysis of *gaze duration* yielded effects of valence, $F(2, 46) = 5.52$, $p < .01$, and visual field, $F(1, 23) = 7.86$, $p < .01$. Gaze duration was shorter for the unpleasant and the pleasant pictures than for the neutral pictures (both $ps \leq .05$), and it was shorter in the left than in the right visual field (250 vs. 308 ms, respectively). The total *number of first-pass fixations* on each picture was influenced by valence, $F(2, 46) = 11.68$, $p < .0001$, and visual field, $F(1, 23) = 5.22$,

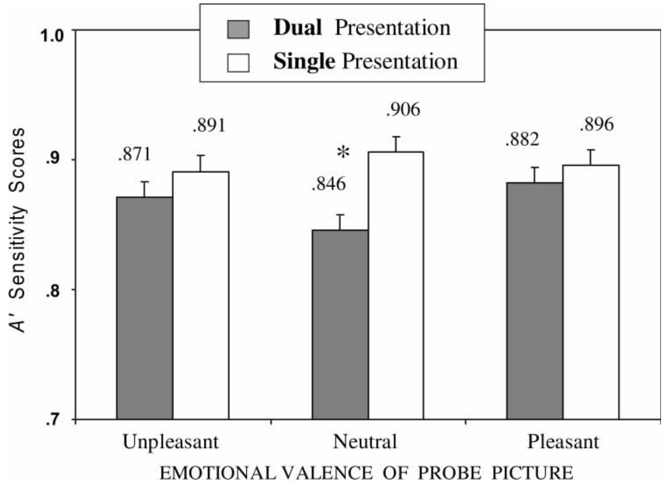

Figure 1. *Interaction between type of presentation and emotional valence of scenes, for* A′ *sensitivity scores (with error bars denoting standard error; the asterisk indicates significant differences between the single- and the dual-prime presentation).*

$p < .05$. Pleasant and unpleasant pictures attracted more fixations than did neutral pictures (both *p*s $< .01$); primes in the right visual field attracted more fixations than did those in the left (.526 vs. .441, respectively). The *encoding efficiency* index (i.e., A' score/gaze duration * 100) was affected by valence, $F(2, 46) = 7.27$, $p < .01$, and visual field, $F(1, 23) = 5.49$, $p < .05$. Efficiency was greater for the unpleasant and the pleasant pictures than for the neutral pictures (both *p*s $< .05$), and it was greater in the left than in the right visual field (.389 vs. .330).

Discussion

This study investigated the preferential processing of emotional scenes competing for attentional resources with neutral scenes. Pictures were presented briefly (450 ms) and peripherally (5.2°) in a dual-prime, competing condition, or in a single-prime condition. Preferential processing was assessed for (a) accuracy of identifying specific scene content, (b) selective initial orienting to one of two competing stimuli, and (c) encoding efficiency (the amount of attention required for content identification). All three measures provided support for the hypothesis of preferential processing of emotional scenes.

The interactions between type of prime presentation (single vs. dual) and scene valence revealed a poorer identification of neutral scenes due to stimulus competition. Hit rate and recognition sensitivity were equivalent for emotional and neutral scenes in the single-prime condition. In

Table 3. *Mean probability of first fixation on a picture, saccade latency of the first fixation, first-pass gaze duration, number of first-pass fixations, and encoding efficiency, as a function of emotional valence of scenes*

Valence	*Probability of first fixation*	*Saccade latency*	*Gaze duration*	*Number of fixations*	*Encoding efficiency*
Unpleasant	.319[a]	237[a]	264[a]	0.510[a]	.369[a]
Neutral	.231[b]	255[b]	308[b]	0.431[b]	.323[b]
Pleasant	.330[a]	224[a]	264[a]	0.510[a]	.387[a]

Note: Saccade latency in ms. Gaze duration in ms. Encoding efficiency = (A' sensitivity/gaze duration) * 100.
[a,b]A different superscript indicates significant differences between valence categories.

contrast, hit rate was higher for emotional than for neutral scenes in the dual-prime condition. Moreover, there was impairment in sensitivity in the dual-prime condition for the neutral but not for the emotional scenes. This suggests that there was a reduction of attentional resources devoted to the neutral pictures in the presence of emotional pictures. The lack of differences between emotional and neutral scenes when they were presented singly rules out the alternative interpretation that the former would be more easily perceivable and/or retrievable than the latter due to greater distinctiveness, less complexity, and so on, regardless of competition for limited resources.

Preferential processing of emotional stimuli has also been demonstrated with other paradigms. In the exogenous cueing paradigm, a spatially invalid emotional cue (a picture appearing on the opposite side of the probe) draws attention to a greater extent than does an invalid neutral cue, as indexed by a delay in probe detection. Importantly, these effects appear even when the emotional meaning of the cue is task irrelevant (Fox, Russo, Bowles, & Dutton, 2001; Yiend & Mathews, 2001). The findings obtained with dot-probe (e.g., Mogg et al., 2004) and visual search tasks (e.g., Juth et al., 2005) converge in showing an advantage in the processing of emotional over neutral information, when there is competition for limited cognitive resources (see the Introduction).

Two cognitive mechanisms responsible for this advantage were explored in the current study: selective orienting and encoding efficiency. The former involves directing attention first to the emotional scene, which ensures that this stimulus is more likely to be processed than the neutral stimulus. The latter involves encoding emotional scenes with reduced processing resources, which implies that identification of the stimulus content is performed efficiently. Both mechanisms facilitate processing of emotional scenes, although the time course and the nature of the attentional resources involved are different in these two accounts. While biased attentional selection is executed before the stimulus is overtly fixated, efficient encoding operates upon or after landing a fixation on the stimulus. We obtained evidence for both mechanisms.

Regarding the selective orienting mechanism, the emotional scenes were more likely to be fixated first than were the paired neutral scenes. This finding is consistent with those of Calvo and Lang (2004) and Nummenmaa et al. (2006). However, the finding of shorter saccade latencies towards emotional than towards neutral scenes is novel, as Calvo and Lang (2004) and Nummenmaa et al. (2006) did not find an effect of emotional valence on saccade latency. By not imposing a strict time constraint in the two previous studies (the stimuli were presented for 3 s, and no speeded saccadic response was required), the saccadic latency measure presumably became less sensitive. In contrast, in the current study with the limited exposure time (450 ms), fast saccade programming was necessary if both pictures were to be fixated. The important implication of these findings is that the orienting mechanism is not only selectively biased towards emotional stimuli (indexed by the probability of first fixation) but that it is triggered faster by these stimuli (indexed by shorter saccade latencies).

These selective orienting effects suggest that something of the emotional scenes must have been perceived by covert attention before overt attention is directed to them. The question is whether this “something” involves meaningful content or merely low-level visual features. According to theories based on saliency mapping (Itti & Koch, 2000), covert attention precedes eye movements in the selection of saccade targets. On each fixation, attention is guided first to the scene or scene region that has the highest weight within the saliency map, with weight being initially determined by perceptual factors such as luminance and colour. The fact that our emotional and neutral scenes were comparable in luminance, contrast, and so on, argues against such an account of the differences in attentional orienting and suggests that semantic processing of emotional scenes can begin before these are fixated. The possibility that meaning, at least the gist of scenes, is extracted outside of foveal vision has received empirical support (Gordon, 2004; Underwood, 2005).

Furthermore, the view that affective significance can be extracted in parafoveal vision by means of covert attention—that is, without fixating the stimuli—is consistent with recent data obtained by Calvo and Nummenmaa (in press).

Regarding the processing efficiency mechanism, gaze duration was shorter on emotional than on neutral scenes, when both were fixated. Furthermore, the amount of overt attention invested to obtain accurate scene identification was smaller for emotional than for neutral scenes, as shown by the higher ratio between the sensitivity index and gaze duration. This reveals that fewer encoding resources are needed to process emotional scenes. Once fixated, their content can be identified faster than that of neutral scenes. Interestingly, a greater number of fixations occurred on emotional than on neutral pictures, even though gaze duration was shorter for the former than for the latter. This implies that emotional scenes were scanned more quickly, thus showing greater efficiency. This reduction of encoding resources does not, however, imply that attention is not necessary for the processing of emotional pictures. Pessoa and his collaborators (e.g., Smith-Erthal et al., 2005) have demonstrated that cognitive and neural processing of emotional stimuli is dependent on the number of available attentional resources.

There is a potential alternative interpretation of this greater efficiency for emotional scenes. Efficiency could be due to differences in visual similarity between the target and the matched scenes rather than due to their meaningful content. Sensitivity scores were obtained using a task requiring discrimination between target and matched scenes. Thus it is possible that the emotional scenes were identified more efficiently simply because the target and the matched emotional scenes were more different than the corresponding neutral scenes. However, the fact that there were no differences in sensitivity scores when scenes were presented singly argues against this explanation. Any difficulty in discriminating between the target and matched neutral scenes was restricted to the condition entailing competition for attentional resources.

In conclusion, when emotional and neutral scenes are presented simultaneously, eccentrically, and briefly—thus in competition for limited attentional resources—emotional scenes are better identified than neutral scenes. This is due both to covert attention being initially captured by emotional content prior to fixation—which then guides overt attention towards the emotional stimulus—and to less overt attentional resources being needed to encode the semantic content of emotional stimuli.

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APPENDIX A

International Affective Picture System (IAPS) numbers for photographs used in the experiment

The IAPS numbers for the target scenes (outside parentheses) and the corresponding matched scenes (within parentheses) were: (a) neutral pictures: 2037 (2357), 2190 (2493), 2191 (2191.1), 2220 (2200), 2221 (5410), 2270 (9070), 2272 (2272.1), 2312 (2312.1), 2383 (2372), 2393 (2393.1), 2394 (2305), 2396 (2579), 2397 (2397.1), 2512 (2491), 2513 (2513.1), 2560 (2560.1), 2575 (2575.1), 2593 (2593.1), 2594 (2594.1), 2595 (2595.1), 2598 (2598.1), 2635 (2635.1), 2745.1 (2745.2), 2749 (2749.1), 2840 (2410), 2850 (2515), 2870 (2389), 7493 (2102), 7496 (7496.1), 7550 (7550.1), 7620 (7620.1), and 9210 (9210.1); (b) unpleasant pictures: 2399 (2399.1), 2691 (2683), 2703 (2799), 2718 (2716), 2800 (2900), 2811 (6250), 3180 (3181), 3225 (3051), 3350 (3300), 6010 (2722), 6313 (6315), 6550 (6560), 8485 (8480), 9254 (9435), 9410 (9250), and 9423 (9415); and (c) pleasant pictures: 2070 (2040), 2165 (2160), 2540 (2311), 2550 (2352), 4599 (4610), 4647 (4694), 4658 (4680), 4669 (4676), 4687 (4660), 4700 (4624), 5621 (8161), 5831 (5836), 7325 (2332), 8186 (8021), 8200 (8080), and 8490 (8499).