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That Baby Caught My Eye . . . Attention Capture by Infant Faces

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An alternative to the view that during evolution the human brain became specialized to preferentially attend to threat-related stimuli is to assume that all classes of stimuli that have high biological significance are prioritized by the attention system. Newborns are highly biologically relevant stimuli for members of a species, as their survival is important for reproductive success. The authors examined whether the *Kindchenschema* (baby schema) as described by Lorenz (1943) captures attention in the dot probe task. The results confirm attentional capture by photos of human infants presented to the left visual field, suggesting right hemisphere advantage. The magnitude of the attentional modulation was highly correlated with subjective arousal ratings of the photos. The findings show that biologically significant positive stimuli are prioritized by the attention system.

Keywords: attention, emotion, relevance

It is of obvious adaptive value to pay special attention to objects that may be important for the well-being of the organism. In this context, it has been suggested that the human brain implements a fear module subserving selective attention to potentially threatening stimuli such as snakes or angry faces (Öhman & Mineka, 2001). Recently, it has even been proposed that phylogenetic changes in the visual system of primates were mainly driven by evolutionary coexistence with venomous snakes (Isbell, 2006). Findings indicating faster detection times for threatening as compared with neutral stimuli in paradigms such as the dot probe task (e.g., Lipp & Derakshan, 2005) or the visual search task (e.g., Brosch & Sharma, 2005) are considered to support the notion of a preferential processing of threatening stimuli by the brain.

An alternative to the view that during evolution the human brain became specialized to preferentially perceive threat-related stimuli is to assume that all classes of stimuli that have high biological significance are prioritized by the attention system. Appraisal theories of emotion have suggested that an early and critical evaluation process is responsible for detecting the extent to which stimulus events are relevant for the hierarchy of goals and needs of the individual (e.g., Sander, Grandjean, & Scherer, 2005; Scherer, 2001). In particular, it is predicted that increased allocation of attention to highly relevant stimuli or events, independent of their valence, will lead to enhanced processing and perceptual analysis of the event and trigger synchronized changes in the autonomic, motor, and motivational system to prepare the organism for adaptive responses to the stimulus event (e.g., Scherer, 2001).

Newborns are a prototypical example of a highly biologically relevant stimulus for members of a species. Lorenz (1943) described the *Kindchenschema* (baby schema), a configuration of perceptual features found in newborns across species, including, for example, a high, slightly bulging forehead, large eyes, and rounded cheeks. Lorenz observed that humans respond to these key stimuli with positive emotions and behavior patterns of parental care such as increased attention to the helpless infant. The care that parents provide for their newborn children is important for reproductive success and thus of high adaptive value. Furthermore, parental responses elicited by the *Kindchenschema* are considered an important factor in the subsequent development of secure infant attachment (Ainsworth, Blehar, & Waters, 1978).

The impact of the *Kindchenschema* on humans has been confirmed by more recent studies. The degree of *Kindchenschema* in faces is correlated with positive attributions such as cuteness, warmth, fondness, and honesty (Berry & McArthur, 1985). Also, mothers showed higher activation of the intraparietal sulcus and the precuneus, brain areas associated with attentional processes, when watching images of young children compared with pictures of adults (Leibenluft, Gobbini, Harrison, & Haxby, 2004).

In this study, we examined the hypothesis that pictures of infants displaying the *Kindchenschema* have a facilitating effect on the attentional system when compared with pictures of adults. Although recent studies have already relativized the assumption that search advantages for threatening stimuli in tasks such as the visual search task reflect a selective modulation of attention by fear-relevant stimuli (e.g., Lipp, 2006), to our knowledge this is the first study to directly investigate the hypothesis that a functionally defined, biologically significant positive stimulus modulates attention.

Considering the special biological role of women in the upbringing of children, we also investigated whether women show stronger attentional bias toward *Kindchenschemata* than men. Although it has been suggested that women are emotionally more expressive and sensitive than men (e.g., Kring & Gordon, 1998), not much is known about gender-specific differences in the attentional bias toward emotional stimuli.

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To test our hypotheses, we used a variant of the dot probe paradigm, a well-established paradigm for the investigation of attentional biases toward fear-related stimuli in behavioral (e.g., Lipp & Derakshan, 2005; Phelps, Ling, & Carrasco, 2006; see Figure 1A) and brain imaging (Pourtois, Grandjean, Sander, & Vuilleumier, 2004) experiments. Given evidence for right-hemispheric lateralization for the perception of emotional (Borod, 2000) and personally relevant (Van Lancker, 1991) stimuli, we designed our paradigm to be sensitive to functional hemispheric asymmetries by using a divided visual field paradigm with image presentation times of 100 ms to prevent ocular saccades.

Method

Participants and Stimuli

Forty-one participants (20 men and 21 women, mean age 24.5 years, all right-handed and with normal or corrected-to-normal vision) were recruited on the premises of the University of Geneva and received 10 Swiss francs for their participation. Eight black-and-white pictures from each of the categories babies, human adults, kittens, adult cats, puppies, and adult dogs were obtained from the Internet. The human stimuli all showed neutral facial expressions.

In a preliminary study, all images were rated for pleasantness and arousal by 11 individuals who did not participate in the main experiment. Participants viewed the images separately on a computer screen and indicated their rating of pleasantness and arousal using analog sliders that covered a range between 1 (*very unpleasant/not arousing at all*) and 100 (*very pleasant/very arousing*). Table 1 shows the means and standard deviations for the ratings for all categories. Within each species (humans, cats, and dogs), significantly higher arousal ratings and more positive ratings were obtained for the infant (*Kindchenschema*) than the adult stimuli.

The photo set was analyzed for category differences in luminance, contrast, and mean energy in spatial frequency bands (2–4, 4–8, 8–16, 16–32, 32–64, 64–128, 128–256, and 256–512 cycles/image). No significant differences were found.

Procedure and Data Analysis

Each trial started with a fixation cross presented for a random interval of between 250 and 750 ms. Then the cue, which consisted of two images presented in the left and right parts of the screen, was presented for 100 ms. The images belonged either to the same category or to two categories of the same species (e.g., baby–adult). The images and the respective cuing conditions were presented in randomized order.

The images had a size of 7 × 7 cm on the screen and were presented at a distance of 15 cm between fixation cross and image center. Participants were placed 100 cm from the screen. This resulted in a visual angle of 8.5° between the fixation cross and the center of the image. Afterward, a small dot appeared for 200 ms, replacing one of the images. In a valid trial, the dot replaced the *Kindchenschema* image; in an invalid trial, the dot replaced the adult image. In a neutral trial, both images depicted adults. One third of the trials were trials without a dot to prevent participants from developing response strategies. Participants were instructed to indicate whether a dot appeared in the left or right part of the

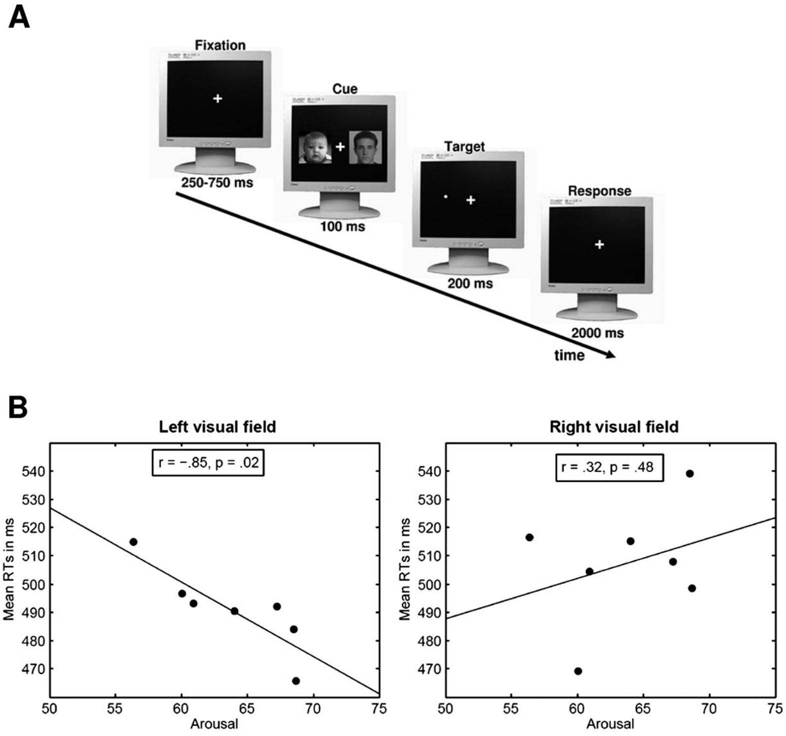

Figure 1. Experimental sequence (A). Correlation between arousal ratings and response times in valid trials for pictures displaying human infants for presentation in the left and right visual fields, respectively (B).

Table 1
Results of the Rating Study (N = 11): Mean Ratings of Pleasantness and Arousal for All Categories

	Pleasantness			Arousal		
Stimuli	*M*	*SE*	*p*	*M*	*SE*	*p*
Babies	75.62	3.07		61.53	2.66	
Adults	49.16	0.82	>.001	35.49	1.78	>.001
Kitten	71.18	1.87		53.71	1.20	
Cats	50.62	2.20	>.001	44.78	0.72	>.001
Puppies	77.98	2.54		56.21	1.97	
Dogs	63.25	2.47	.001	46.91	2.88	.02

Note. Ratings ranged from 1 (*very unpleasant /not arousing at all*) to 100 (*very pleasant/very arousing*). The *p* values refer to the differences in ratings between infant and adult stimuli.

screen. They responded by pressing a key on the computer keyboard—“C” if the dot appeared on the left, “M” if it appeared on the right, and the space bar if there was no dot. Participants had a maximum of 2,000 ms to respond, after which the next trial started. Participants performed a total of 360 experimental trials. The experiment was presented on an IBM-compatible PC using E-Prime software (Psychology Software Tools, Pittsburgh, USA; www.pstnet.com/eprime). Only response times of correct responses lying within 3 standard deviations of the mean for the respective individual were analyzed. Following the procedure in previous studies using the dot probe task with threatening stimuli (e.g., Lipp & Derakshan, 2005), only the valid and invalid trials were included in the analysis. Response times were analyzed in a 3 × 2 × 2 × 2 analysis of variance design including the repeated factors cue species (humans, cats, and dogs), visual hemifield of the target (left or right), and cue validity (valid or invalid) and the between-subjects factor sex (male or female). In addition, we analyzed the cuing bias for each cue species in each hemifield with planned contrasts (humans invalid left visual hemifield [VHF]–humans valid left VHF; humans invalid right VHF–humans valid right VHF; cats invalid left VHF–cats valid left VHF; cats invalid right VHF–cats valid right VHF; dogs invalid left VHF–dogs valid left VHF; dogs invalid right VHF–dogs valid right VHF).

Results

Data from three participants (1 man and 2 women) were excluded from the analysis because of error rates greater than 15%. Average error rate was 4.2%. Table 2 shows the response times for the human and the animal stimuli per cuing condition and visual hemifield and the attentional modulation index (invalid–valid trials) in milliseconds. When the target was presented in the left visual field, response times were lower on valid (484 ms) than on invalid (495 ms) trials. When the target was presented in the right visual field, response times on valid (498 ms) and invalid (496 ms) trials did not differ. The lateralized cueing bias effect of the emotionally positive stimuli is reflected in the Visual Hemifield × Cue Validity interaction, $F(1, 36) = 5.69$, $p = .022$, partial $\eta^2 = .14$. The Visual Hemifield × Cue Validity × Species interaction was not statistically significant, $F(2, 72) = 0.73$, $p = .44$. The statistical power $1 - \beta$ of this test to detect a small effect of $f = .1$ (Cohen, 1988) was .49, so the nonsignificant statistic might be due to a Type II error.

When analyzing the attentional modulation indices per cuing species and visual hemifield, only the contrast for human images presented to the left visual hemifield turned out to be significant, $F(1, 36) = 5.17$, $p = .028$.

With regards to sex differences, neither the main effect of sex nor any interaction involving sex reached statistical significance (all *p*s > .21). In addition, but less relevant for our hypotheses, a main effect for species showed faster response times toward dog stimuli than toward cat stimuli, $F(2, 72) = 4.40$, $p = .016$, partial $\eta^2 = .11$; response times toward human stimuli did not differ from the other categories.

Table 2
Mean Response Times and Attentional Modulation Index (Invalid–Valid Trials) for the Human and Animal Stimuli (Aggregated Across Dogs and Cats) in Milliseconds

	Trial type							
	Valid		Invalid		Neutral			
Stimuli and target hemifield	*M*	*SE*	*M*	*SE*	*M*	*SE*	Attentional modulation index	*p*
Humans								
LVF	480	10.5	498	13.8	497	12.0	18	.028
RVF	498	11.2	498	12.1	499	11.1	0	*ns*
Animals								
LVF	488	11.1	492	10.9	488	11.3	4	*ns*
RVF	497	9.9	494	10.7	493	10.9	–3	*ns*

Note. LVF = left visual field; RVF = right visual field.

To further investigate the attentional modulation effect for pictures of human infants, and especially the relation between pleasantness, arousal, and the attentional bias, we correlated the response times in valid trials with the arousal and pleasantness ratings of the pictures obtained in the preliminary study.[1] Figure 1B shows the arousal ratings and the response times for presentation of pictures of human infants in valid trials in the left and right hemifields. After removal of one outlier that was more than 2 standard deviations below the mean arousal value, the correlation between arousal and response time for presentation in the left visual hemifield was $-.85$ ($p = .015$). Neither the correlation for right visual hemifield presentation ($r = .32$, $p = .48$) nor any correlation involving pleasantness ratings or animal stimuli was statistically significant.

Discussion

In this study, we investigated whether pictures of faces displaying the configurational features of the *Kindchenschema*—a strong emotionally positive stimulus with high biological significance—have an effect on the spatial deployment of attentional resources in the dot probe paradigm. Congruent with our hypothesis, results suggest attentional capture by human infants displaying the *Kindchenschema*. Response times in valid trials decreased with increasing arousal ratings of the cuing stimulus images presented in the left visual field.

In contrast to studies indicating that faster response times toward emotional stimuli are a result of a prolonged disengagement (Posner & Petersen, 1990) from emotional distractors (e.g., Fox, Russo, & Dutton, 2002), both the pattern of response times and the correlation between arousal ratings and response times in valid trials suggest that the *Kindchenschema* pictures captured attention.

The effect was specific for human stimuli, which might reflect an adjustment of the human brain to the perception of conspecifics. Furthermore, the effect was restricted to left visual field presentation, which corresponds to a right hemisphere advantage. This is consistent with our hypothesis as the right hemisphere is considered dominant for the processing of faces and configurations (Farah, Wilson, Drain, & Tanaka, 1998), the perception of emotional stimuli (Borod, 2000) and personally relevant stimuli (Van Lancker, 1991), and attentional processes in general (Heilman & Van Den Abell, 1980). The lateral specificity of the observed modulation strengthens our claim that the observed effect is an emotional modulation of attention.

Furthermore, the observed sensitivity of the right hemisphere for infant perception is in line with the universally observed leftward bias for holding babies (Vauclair & Donnot, 2005).

Attentional bias seems to be modulated by the stimuli's arousal potential. This is consistent with theoretical expectation and published data. On the one hand, appraisal theories of emotion predict that the evaluation of a stimulus as significant leads to increased processing of the stimulus and triggers changes in the autonomic system that prepare the organism for adaptive action (Sander et al., 2005). On the other hand, subjective arousal ratings are highly correlated with autonomic activation (Lang, Greenwald, Bradley, & Hamm, 1993). The observed correlation between the response times for right hemisphere presentation and arousal ratings might reflect the synchronization of the attentional and the autonomic system in response to the stimulus. The correlation was only observed for right hemisphere presentation. This is consistent with the dominant role of this hemisphere in emotional processing (see above) and in autonomic activation and control, as indicated, for example, by a reduction of autonomic activation toward presentation of emotional material in patients with right hemispheric lesions (Gainotti, 2001).

Considering the special biological role of women in the upbringing of children, one might have expected to find a stronger attentional effect in female participants. Conversely, based on findings that men show a greater degree of cerebral lateralization toward the right hemisphere both for the processing of faces (Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006) and for the processing of positive facial expressions (Bourne, 2005), one might have expected an advantage for men. However, in this study no gender differences were found for the attentional bias. No conclusion can be drawn from the absence of an effect, and further research, using different experimental paradigms, needs to be performed to examine potential gender differences in the perception of infant faces.

Our results mirror findings showing shorter response times toward threatening stimuli than toward neutral stimuli in behavioral tasks. Together with findings showing reduction of the attentional blink for positively and negatively arousing words (Anderson, 2005) and attentional interference for a secondary task by the presentation of both positive and negative pictures (Schimmack, 2005), our results support the notion that a common evaluative process may be responsible for the emotional modulation of selective attention to both negative and positive affectively arousing stimuli (Scherer, 2001).

The neural substrates and processes involved in the prioritization of threat-related stimuli have been investigated extensively, showing an important role of the amygdala and its projections to sensory areas (Vuilleumier, 2005). On the basis of our demonstration that positive biologically significant stimuli are prioritized by the attention system, further research should examine whether the same neural system is involved in the orienting of attention toward biologically relevant stimuli (Sander, Grafman, & Zalla, 2003).

A further issue that might be addressed in subsequent research concerns the question of whether attentional bias is caused by specific components of the *Kindchenschema* or the overall pattern of configurational cues that make up the human infant's face.

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