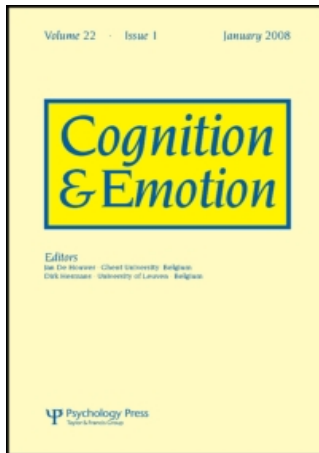


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## **Inhibition of return is unimpressed by emotional cues**

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Inhibition of return (IOR) is a phenomenon observed when a target unexpectedly appears in the place of a preceding cue: With long cue–target stimulus onset asynchronies, reaction times are longer than for targets that appear in an alternative location. Cognitive theories of anxiety suppose that the IOR effect diminishes with threatening, biologically relevant cues because these catch and hold attention. To test this hypothesis, we conducted three experiments, in which emotional valence of cues (animals or facial expressions) had no influence on the strength of the IOR effect, neither in an unselected sample of students nor in highly spider-fearful or socially anxious participants. Inhibition of return appears to be a robust effect, blind to cue valence.

According to theories of information processing, attention is a highly automated system striving to optimise quick and accurate perception of objects and changes in the visual field (Yantis, 1996). Several authors have supposed that two distinguishable attentional systems control voluntary and automatic orienting, respectively (Norman & Shallice, 1986; Posner, 1980;

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Posner & Petersen, 1990). While the endogenous attentional system (voluntary orienting) appears to be located in the anterior brain areas, for example the anterior cingulate cortex, the exogenous attention system (reflexive orienting) is located in the parietal lobe, the pulvinar, and the superior colliculus (Roelofs, van Galen, Eling, Keijsers, & Hoogduin, 2003; see: Pardo, Pardo, Janet, & Raichle, 1990; Petersen, Fox, Miezen, & Raichle, 1988, for details). Moreover, it has been found that the reflexive attentional system exhibits a certain kind of “novelty bias”, in that attention is allocated to specific locations only if it is likely that a new stimulus is going to appear in this location. If you are, for example, riding in your car and a ball rolls onto the street in front of you, your alertness increases because you expect a child running after the ball. The ball is a *cue* with some predictive value, that is, there is a high chance that the ball will be followed by a child (a *target* of attention). Therefore, you voluntarily orient your head towards the location where you first spotted the ball. If, after some elapsed time, no child has appeared to get the ball, its predictive value declines and so does the alertness to this specific cued location. It might even be the case that it is now more difficult to redirect your attention to the “ball location” because you have already looked there and nothing happened. One has to be aware, though, that this simplified example refers to endogenous redirection of attention, a voluntary movement. Imagine now having made the experience sketched above several hundred times, each time with a child following the ball. It is very likely that the redirection of your attention to the ball has become automatized—reflexively triggered whenever a cue is detected. Taylor and Therrien (2005, p. 1414) suppose that the cued position receives a “... hypothetical location-based inhibitory tag [which] marks the location as *visited*”, and then inhibits subsequent return of attention to the same location. This phenomenon has been termed *inhibition of return* of attention (compare: Klein & Taylor, 1994; Posner, Rafal, Choate, & Vaughan, 1985; Taylor & Klein, 1998, 2000).

Inhibition of return has been investigated mainly with a task employing two possible locations for cues and targets on a computer screen. In this task, a cue stimulus appears randomly in one of the two locations, disappears, and is then followed by a target cue, which appears either in the cued location (called a *valid* trial) or in the uncued location (*invalid* trial). If the target follows the cue quickly, people often show a faster reaction to targets on valid trials than on invalid ones, a phenomenon called *facilitation by cueing*. If there is a delay between cue onset and target onset, the pattern reverses, and *inhibition of return* (IOR) occurs. Posner and Cohen (1984) suggested that the temporal limit which separates facilitating cueing effects from IOR effects lies around an SOA of 300 ms (i.e., if the cue appears 300 ms earlier than the target), and Samuel and Kat (2003) found that the IOR effect is surprisingly stable between SOAs of 300 ms and 3300 ms.

Moreover, inhibition of return of one's attention to a formerly cued location has biological and evolutionary implications. It prevents repeated scanning of irrelevant locations that have already been sampled, promoting more efficacy of the attentional system (Klein & MacInnes, 1999; Lupianez, Klein, & Bartolomeo, 2006).

Independently of these findings, several authors have proposed that stimuli related to danger may be processed pre-attentively, and therefore particularly rapidly. In general, a pre-attentive analysis of stimuli makes evolutionary sense, for instance because fast detection of danger in the environment allows for faster reactions and, hence, a higher chance of survival (LeDoux, 1996; Öhman, 1993; Öhman & Soares, 1993). Additionally, Mineka and Öhman (2002) assumed that mammals possess an evolved fear system, pre-programmed to rapidly detect specific (formerly life-)threatening stimuli such as spiders, snakes, heights, and (socially) threatening facial expressions of others. Neurobiological research confirms that certain stimuli appear to have a kind of "biological hardwiring" that facilitates the identification and categorisation of some stimuli above others: e.g., spiders and snakes (Öhman, Flykt, & Esteves, 2001; Öhman & Mineka, 2001), or emotional facial expressions (Haxby, Hoffman, & Gobbini, 2000; Herrmann, Ehlis, Muehlberger, & Fallgatter, 2005; Vuilleumier, 2002; Vuilleumier & Pourtois, 2007). Therefore, reflexive orienting and the emotional relevance of these biologically or evolutionarily encumbered stimuli are of great interest in experimental psychopathology. For instance, it is supposed that an increased threat sensitivity or threat appraisal of anxiety patients biases their reflexive orienting to threatening stimuli, and by doing so initiates or maintains anxiety disorders (e.g., Eysenck, 1992; Fox, Russo, Bowles, & Dutton, 2001; Mathews & MacLeod, 2005; Williams, Watts, MacLeod, & Mathews, 1988). Hypervigilance for (biologically) threatening cues, the reflexive allocation of attention to threat and the aggravated disengagement of attention from threat in anxiety patients have been termed *attentional biases*.

If one combines the findings and theoretical explanations of IOR with those of attentional biases, it seems that inhibition of return and attentional biases for biologically relevant threat stimuli may contradict each other under certain circumstances (see also Theeuwes & van der Stigchel, 2006). In particular, the IOR effect should be weakened when the cue is biologically relevant and threatening. In this case, even if the threatening cue does not predict the location of the following target, it should catch and hold attention, such that targets appearing in its location will be advantaged rather than disadvantaged compared to targets appearing in another location. If this is indeed the case, the enhanced relevance of threatening cues in patients with an anxiety disorder may actually lead to a complete dissipation of the IOR effect. Indeed, there appears to be some evidence for this suggestion. Fox, Russo, and Dutton (2002) concluded from their results

that angry faces employed as invalid cues do indeed eliminate the IOR effect in highly trait-anxious participants. In Experiment 2 of their study, they examined whether relevant emotional stimuli (schematic faces) would reduce the IOR effect, and whether the reduction would be more pronounced in high trait-anxious participants. Their results suggested a general reduction of the IOR effect following angry cues, but not neutral or smiling cues, in both high and low trait-anxious participants. In Experiment 3, all participants underwent a mood induction and a jumbled face replaced the smiling face in order to rule out low-level visual features as an explanation of the results. In this study, specific reductions of the IOR effect were found, however, for several reasons, the results have to be interpreted cautiously. First, jumbled faces produced the same IOR reduction as angry faces. Second, it appeared that the mood induction only worked for high trait-anxious individuals and not for the non-anxious controls. Consequently, group differences may be inflated by the unsuccessful anxiety induction in the non-anxious controls. Third, Fox et al. (2002) directed participants' attention to the fixation point again after cue presentation: "The cue was subsequently blanked out and 200 ms later the central cross was darkened for a further 300 ms. The initial fixation display was then presented for 160 ms and then the target was presented". (Fox et al., 2002, p. 367). This redirection of the participants' attention to the central fixation point between presentation of cue and target is not seen often, and its impact on the observed reaction times remains unclear. Nevertheless, the results contradict those of Taylor and Therrien (2005), who found that the IOR effect was not reduced by facial cues. None of these studies employed other biologically relevant cue stimuli, for instance threatening animals, and none studied the effects of these stimuli in groups differing in their specific fear of these stimuli.

The purpose of the present study, therefore, was to test the prediction of a reduced IOR effect following biologically relevant cues in different populations. To this end, we used versions of Posner's covert orienting paradigm (Posner, 1980). Posner distinguishes two types of orienting: *overt* with movement of head and/or eyes, and *covert* without moving head and eyes (Posner, 1980). In experiments employing this paradigm, participants are asked to react to a target presented anywhere in their visual field, while keeping their eyes focused on a central fixation cross. Before the appearance of the target, a cue appears either in the same location as the target (a valid cue) or in a different location (an invalid cue). In the experiments reported here, the stimulus onset asynchrony of cue and target was varied, as was the valence of the cue. In Experiment 1, drawings of a spider, a butterfly, and a cross (Experiment 1A) were used as cues, as well as pictures of angry, neutral, and smiling individuals (Experiment 1B). With neutral cues and longer SOAs (> 300 ms), cueing is generally thought to cause IOR, that is, facilitated

target detection on invalid trials compared to valid ones. Therefore, we employed an SOA of 550 ms for all cues. The critical question was whether in an unselected student sample, the IOR effect would be reduced for threatening, biologically relevant stimuli (spiders and angry faces), or for emotionally valenced stimuli in general (spiders, butterflies, angry and smiling faces), as opposed to neutral stimuli (crosses and neutral faces).

To find out whether the biologically relevant cues gain sufficient threat value when presented to highly fearful participants, the task containing spider, butterfly, and cross cues was repeated with selected samples of highly spider-fearful participants versus non-fearful ones (Experiment 2). The prediction was that the IOR effect would generally be reduced by spider cues, and that spider fearfuls might not show any IOR effect at all after spider cues. In Experiment 3, the biologically relevant cues were again angry, neutral, and smiling facial expressions. It is supposed that an angry expression inflicts threat on human beings in general (Hansen & Hansen, 1988; Öhman, 2002; Öhman, Lundqvist, & Esteves, 2001) and especially so for socially anxious individuals (Lundh & Oest, 1996; Mogg & Bradley, 1999). Therefore, the same facial cues as in Experiment 1B were presented to selected samples of highly socially anxious versus non-anxious individuals. As in Experiment 1B, a general reduction of the IOR was predicted after cues showing angry facial expressions. Additionally, it was expected that in the highly socially anxious, the IOR might disappear altogether.

## EXPERIMENT 1: EMOTIONAL CUES IN AN UNSELECTED SAMPLE

In Experiment 1, we investigated the influence of evolutionary relevant cues on the magnitude of the IOR. Angry emotional faces as well as spiders are supposed to have an evolutionary threat value to humans, therefore, both types of cues should reduce the IOR effect, such that participants do not react more quickly to invalidly cued targets than to validly cued ones. All participants completed the same set of questionnaires and the same two computerised experimental tasks (Part 1A: spider cues, Part 1B: facial cues).

### Experiment 1: General methods

*Participants.* An unselected sample of 54 students of the University of Nijmegen participated in the experiment (see Table 1). An experimental session contained two computer tasks and lasted for 40 minutes, for which participants received payment of €4 or course credit. Due to registration errors and some missing values, not all data sets could be processed. Consequently, the composition of participants varied slightly between the two tasks and the questionnaires (see below).

TABLE 1

Mean scores ( $M$ ) and standard deviations ( $SD$ ) of age, gender, Fear of Spiders Questionnaire (FSQ), Spider Anxiety Screening (SAS-Spider), approach speed in the Behaviour Assessment Task (BAT;  $\text{cm s}^{-1}$ ), Liebowitz Social Anxiety Scale (LSAS), trait version of the Spielberger State-Trait Anxiety Inventory (STAI-Trait), and Symptom Check List 90 (SCL-90) in Experiment 1 ( $n=54$ )

<i>Variables</i>	<i>M</i>	<i>SD</i>
Age (years)	25.4	(6.8)
Gender (% female)	79.2	
FSQ	14.1	(23.5)
SAS-Spider	6.3	(6.3)
BAT Speed	54.5	(25.3)
LSAS	27.6	(16.5)
STAI-Trait	35.4	(7.7)
SCL-90	129.8	(28.4)

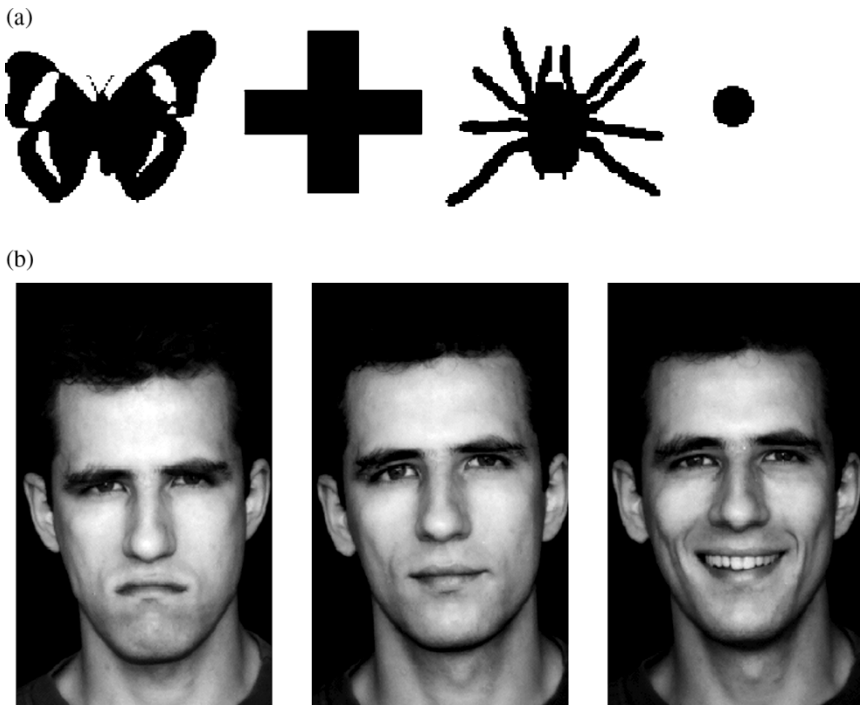
*Procedure.* Before the two computer tasks 1A and 1B, participants filled in a general screening questionnaire for eyesight, handedness, education, and medication; the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987; Oakman, Van-Ameringen, Mancini, & Farvolden, 2003), the Spider Anxiety Screening (SAS; Rinck et al., 2002), the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995), the state version of the State-Trait Anxiety Inventory (here: STAI-State1; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The two computer tasks were conducted on Apple eMac computers with integrated 17" monitors, operating at 700 MHz on Mac OS 10.2.8. Stimulus presentation and reaction time recording was controlled by the software RSVP 4.0.5 for Macintosh (Williams & Tarr, 1998). The order of the two tasks was counterbalanced across participants. After the two tasks, participants filled in the STAI-State again (here: STAI-State2), the Symptom Check List-90 (SCL-90; Derogatis, 1994), the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), and the trait version of the STAI (STAI-Trait). Then they took part in a spider-related behaviour assessment task (BAT): They had to approach a living tarantula in a terrarium as closely and as quickly as possible. The remaining distance to the terrarium and the time until participants stopped approaching was recorded. Afterwards, participants were debriefed, thanked for their effort, and were paid or given course credit.

### Spider Task 1A: Methods

*Materials.* Black-and-white drawings of a butterfly, a cross, and a spider were used as possible cues, and a black dot as the target. The cue pictures were approx.  $110 \times 100$  pixels in size, and the target dot was  $22 \times 22$  pixels in

size. Two empty frames separated by a fixation cross served as possible locations for cues and targets. The two frames were  $146 \times 146$  pixels in size, and the distance between the fixation cross in the centre of the screen and the centres of the frames to the left and right of it was 197 pixels (see Figure 1a).

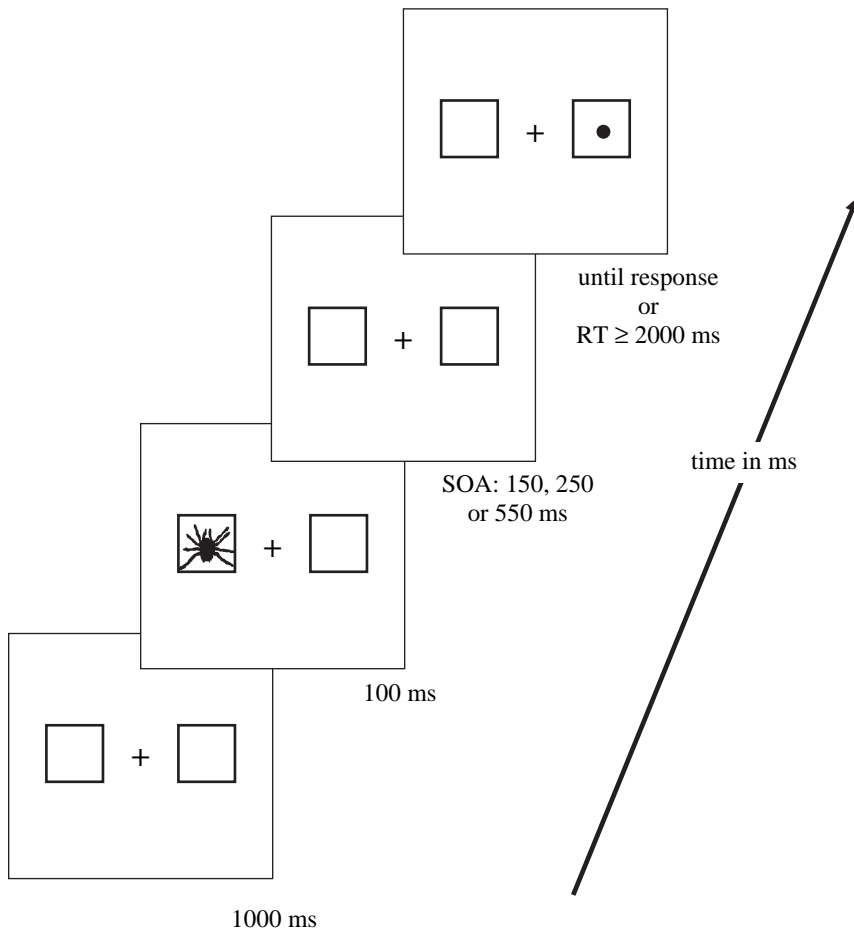
*Procedure.* Participants were seated about 50 cm from the computer monitor. The instructions were as follows: “On the screen, you will always see two empty frames with a fixation cross in between. The task will be easiest if you keep focusing on the fixation cross in the middle. First, in one of the frames a drawing (spider, butterfly, or cross) will be presented. After a while the drawing will disappear by itself. Then, a dot will be presented in one of the frames. You have to press the space bar as quickly as possible whenever you detect the dot in one of the frames. Following the key press, the next trial will start. In a third of the trials, no dot will appear, and you must not react. In this case, the program will continue automatically after 2 seconds”. Participants were given 54 trials to get acquainted with the procedure. In the main part of the task, participants finished 10 sets of 54



**Figure 1.** Sample cues: (a) Butterfly, cross, spider, target dot in Experiments 1A and 2; and (b) angry, neutral, smiling faces in Experiments 1B and 3.



trials each. The total of 540 randomised experimental trials was divided equally into 20 trials for each combination of cue type, validness, and SOA. The sequence of each trial is depicted in Figure 2: A black fixation cross was displayed for 1000 ms in the centre of the white screen with the two black square, empty frames to its left and to its right. Then, one of the cues (cross, spider, or butterfly) was shown for 100 ms in one of the two frames. In two thirds of the trials, the target dot appeared centred in one of the two frames with an SOA of 150, 250, or 550 ms (i.e., 50, 150, or 450 ms after the cue had disappeared). In one third of the trials, no cue appeared. After the participant's response or after 2 s, the next trial began (see Figure 2). The shorter SOAs of 150 and 250 ms were included to undermine the



**Figure 2.** Example of experimental sequence in Experiments 1A and 2.

predictability of the cue–target time lag. These SOAs are not relevant here, therefore they will not be discussed any further.<sup>1</sup>

*Design and analyses.* A 3 (Cue Type: spider, butterfly, cross)  $\times$  2 (Cue Validity: valid, invalid) factorial design was applied to the participants' median reaction times (RTs) in response to dots appearing after an SOA of 550 ms. In addition, IOR effects were calculated by subtracting the median RTs of valid trials from the median RTs of the corresponding invalid trials: Facilitation of validly cued responses results in negative values, whereas positive values denote facilitation of invalidly cued responses, that is, inhibition of return. The participants' IOR effects were correlated with their fear of spiders, measured by SAS, FSQ, and the BAT. Whenever the assumption of sphericity was violated in one of the analyses reported below, more conservative tests were employed (Huynh–Feldt). An alpha level of .05 was used for all statistical tests. The same was true for the analyses of the following experiments. The following predictions were tested: First, responses to invalid trials should be faster than responses to valid trials (the IOR effect). Second, the IOR effect should be reduced after the biologically relevant threat cue, the spider. Third, the IOR effect after spider cues should be negatively correlated with fear of spiders, such that it disappears in participants who are highly spider fearful.

## Spider Task 1A: Results and discussion

Cue validity yielded the expected significant IOR effect on response latencies,  $F(1, 52) = 128.44$ ,  $MSE = 676.74$ ,  $p < .001$ : In general, invalidly cued targets were detected more quickly than targets preceded by a valid cue (343 vs. 367 ms, see Table 2). This IOR effect was also significant for each

<sup>1</sup> Although not of theoretical interest, the SOAs of 150 and 250 ms were also analysed. Unlike some other studies (e.g., Koster, Crombez, Verschuere, Damme, & Wiersema, 2006), we did not find any attentional cueing at these SOAs. Instead, we found stable IOR effects that were unchallenged by cue valence. A thorough analysis of related research reveals that this finding is not as surprising as it might seem at first glance. In fact, the occurrence of IOR instead of facilitative cueing is highly likely, even at short SOAs, under the circumstances employed in our experiments: (a) There is no intermediate cue that would redirect attention to the fixation point (unlike, e.g., Fox et al., 2002). This has been shown to lead to IOR effects at SOAs between 200 and 800 ms (Pratt & Fischer, 2002). (b) Cues and targets were physically different, but appeared in the same spatial location. This has previously produced IOR-like response patterns even for SOAs of 100 and 200 ms, while facilitative cueing occurred when cue and target did not overlap spatially (McAuliffe & Pratt, 2005). McAuliffe and Pratt (2005) systematically investigated the role of target–cue overlap in time and space, and found that spatially overlapping cues did not produce any cueing, regardless of the interstimulus interval (ISI). Instead, they observed IOR at SOAs of 400 and 800 ms across all ISIs. In summary, we have good reason to believe that IOR is a stable process unchallenged by cue valence. Since our results observed at SOAs of 150 ms and 250 ms resemble those found at 550 ms, they are not reported here, in order to save space.

TABLE 2  
Mean RTs and standard deviations (in parentheses) in milliseconds for each cue

Cue validity	Experiment 1A (n=53): Cue type			Experiment 1B (n=54): Cue type		
	Butterfly	Angry	Neutral	Smile	Cross	Spider
Valid	380 (41)	363 (36)	359 (33)	361 (38)	380 (36)	379 (41)
Invalid	345 (41)	342 (35)	342 (40)	342 (34)	346 (38)	349 (38)

cue analysed separately, all  $t(52) > 7.55$ ,  $ps < .001$ . Stimulus type did not have a main effect,  $F(2, 104) < 1$ ,  $MSE = 219.63$ ; and it did not interact with Cue Validity,  $F(2, 104) = 1.13$ ,  $MSE = 215.74$ , *ns*. The correlational analyses corroborated this result: Level of anxiety was not correlated with the IOR effects for any cue. While most measures of spider fear (FSQ, SAS, and BAT) correlated with each other, and all IOR effects correlated with each other, no significant correlation between a measure of fear and an IOR effect was observed (see Table 3).

The results of this task suggest that the IOR effect was unaffected by the biological relevance of the cues preceding the targets. In particular, spider cues did not reduce the IOR effect as compared to a neutral cross cue or positive butterfly cues. Furthermore, and in contrast to the results reported by Fox et al. (2002), the magnitude of the IOR effect was not correlated with the individuals' level of fear, here fear of spiders, as measured by the SAS, the FSQ, or the BAT.

## Faces Task 1B: Methods

Part 1B of Experiment 1 was designed as another test of the hypothesis that biologically relevant cues may reduce the IOR effect by attracting and holding attention at the location of a threatening cue. To this end, a different type of relevant stimulus was used in Part 1B, namely, pictures of individuals

TABLE 3  
Correlations (Spearman's rho) between questionnaire scores, BAT speed ( $\text{cm s}^{-1}$ ), and IOR effects after spider, cross, and butterfly cues in Experiment 1A ( $n=53$ )

	SAS	BAT speed	Butterfly: valid-invalid	Cross: valid-invalid	Spider: valid-invalid
FSQ	.86**	-.25	-.07	.20	.11
SAS		-.33*	-.05	.24	.17
BAT speed			-.08	-.26	-.16
Butterfly: valid-invalid				.73**	.77**
Cross: valid-invalid					.77**

Notes: \* $p < .05$ , two-tailed; \*\* $p < .01$ , two-tailed.

with angry, neutral, or smiling facial expressions. These cues may be better suited for the reduction of the IOR effect than the simple animal drawings used in Part 1A.

*Materials and procedure.* Black and white pictures of two individuals (one male, one female) were presented as cues. Each individual was shown on three pictures, showing an angry, neutral, or smiling facial expression (see Figure 1b). The pictures were  $200 \times 320$  pixels in size. The two location frames were adjusted to the new picture size, yielding  $206 \times 324$  pixels, and the distance between the fixation cross in the centre of the screen and the centre of the frames to the left and right was 142 pixels. The fixation cross and the target dot remained unchanged. The procedure was basically the same as in Experiment 1A, except that the spider, cross, and butterfly cues were replaced by the facial cues showing an angry, neutral, or smiling expression (compare Figure 2).

*Design and analyses.* Again, a 3 (Cue Type: angry, neutral, smiling)  $\times$  2 (Cue Validity: valid, invalid) factorial design was applied to the participants' median RTs in response to dots appearing after an SOA of 550 ms. IOR effects were calculated as above, and they were correlated with social anxiety, as measured by the LSAS. The predictions for Part 1B of Experiment 1 were similar to those of the Part 1A: First, responses to invalid trials should be faster than responses to valid trials (the IOR effect). Second, the IOR effect should be reduced on trials with angry face cues. Third, the IOR effect after angry face cues should disappear with increasing degree of social anxiety.

## Faces Task 1B: Results and discussion

As before, Cue Validity had a significant IOR effect on response latencies,  $F(1, 53) = 106.62$ ,  $MSE = 283.88$ ,  $p < .001$ : Invalidly cued targets were again detected more quickly than validly cued ones (346 vs. 373 ms, see Table 2). The IOR effect was significant for each type of facial cue, all  $t_s(53) > 5.30$ ,  $p_s < .001$ . As before, stimulus type did not have a main effect, nor did it interact with Cue Validity, both  $F(2, 106) < 1$ . Further, the IOR effects for different cues were not correlated with level of anxiety. While the pathology-related questionnaires (LSAS, STAI, SCL-90) showed significant intercorrelations, they did not show any significant relationship with the IOR effects (see Table 4). These results replicate those of Part 1A perfectly, in that the IOR remained robust, regardless of which biologically relevant cue was used. Moreover, participants showed IOR effects that were unrelated to their level of social anxiety (assessed with the LSAS), trait anxiety (STAI), or general level of pathology (SCL-90). These results agree well with those of Taylor

TABLE 4  
Correlations (Spearman's rho) between questionnaire scores and IOR effects after angry, neutral, and smiling facial cues in Experiment 1B ( $n=54$ )

	<i>STAI-Trait</i>	<i>SCL-90</i>	<i>Angry face</i>	<i>Neutral face</i>	<i>Smiling face</i>
<i>LSAS Sum</i>	.53**	.55**	-.02	-.07	.06
<i>STAI-Trait</i>		.71**	-.07	-.01	.06
<i>SCL-90</i>			.03	.03	.16
<i>Angry face: valid-invalid</i>				.05	.29*
<i>Neutral face: valid-invalid</i>					.00

Notes: \* $p < .05$ , two-tailed; \*\* $p < .01$ , two-tailed.

and Therrien (2005), but they are in contrast to those reported by Fox et al. (2002), who also employed emotional facial expressions as cues.

## EXPERIMENT 2: IOR FOR SPIDERS IN SPIDER FEARFULS

The first experiment was conducted following the assumption that some cues are biologically relevant, and to some degree threatening, for all humans. This should hold for spiders as well as for angry faces (Öhman, 2002; Öhman & Soares, 1993). However, the threat value of a cue should also be mediated by the person's individual fear of that particular cue. For instance, a spider should be more significant and more threatening for someone who is highly afraid of spiders, causing stronger effects on this individual than on others (compare: Öhman & Soares, 1993). Consequently, we may have been unable to detect a reduction of the IOR effect in the unselected sample of Experiment 1 because spiders were relevant, but hardly threatening to most participants in this sample. This may also explain the lack of correlations between IOR effects and questionnaires observed in the first experiment. Therefore, we replicated Part 1A of Experiment 1 in a selected sample of highly spider-fearful individuals who were compared to a selected group of non-anxious control participants. In all other aspects, Experiment 2 was a direct replication of Experiment 1A. If threatening stimuli only reduce the IOR effect in highly fearful individuals, we should observe the reduction in the fearful group, but not in the control group.

## Methods

*Participants.* A selected sample of 23 highly spider-fearful participants (SFs) and 24 matched non-anxious controls (NACs) participated in the experiment. All of them were first-year students enrolled at Dresden University of Technology, Germany (see Table 5). An experimental session

TABLE 5

Means (*M*) and standard deviations (*SD*) of age, gender, and questionnaire scores for spider fearfuls (SFs) and non-anxious controls (NACs) in Experiment 2: Fear of Spiders Questionnaire (FSQ), Spider Anxiety Screening (SAS-Spider), trait version of the Spielberger State-Trait Anxiety Inventory (STAI-Trait), Fragebogen zur Depressionsdiagnostik (FDD), and Brief Symptom Inventory (BSI)

<i>Variables</i>	<i>SF (n=23)</i>		<i>NAC (n=24)</i>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (years)	21.0	(1.4)	21.4	(2.0)
Gender (% female)	87.0		87.5	
FSQ**	61.1	(17.7)	2.0	(2.7)
SAS-Spider**	18.4	(3.5)	1.2	(1.7)
STAI-Trait	40.4	(6.9)	41.6	(7.2)
FDD	9.0	(5.2)	7.6	(4.6)
BSI	0.6	(0.3)	0.6	(0.4)

*Notes:* \* $p < .05$ , two-tailed; \*\* $p < .01$ , two-tailed.

lasted for 20 minutes, for which participants received payment of €2 or course credit.

*Materials, apparatus, and procedure.* These were identical to those of Experiment 1A, except for the following aspects of the procedure: During first-year lectures, students were asked to fill in the SAS. They were invited to participate in the experiment if they scored below 6 points (NACs) or above 14 points (SFs) on the SAS. Upon arrival at the lab, participants filled in the SAS again and also the FSQ. If they scored below 12 or above 30 on the FSQ, they were admitted to further testing, and they completed the remaining questionnaires. The “*Fragebogen zur Depressionsdiagnostik nach DSM-IV*” (FDD; Kühner, 1997), which is the German version of the Inventory to Diagnose Depression (IDD; Zimmerman, Coryell, Corenthal, & Wilson, 1986), was added to the set of questionnaires. The rest of the procedure was identical to that of Experiment 1A.

*Design and analyses.* Full combination of the within-subjects factors Cue Type (spider, butterfly, cross) and Cue Validity (valid, invalid) with the between-subjects Factor Anxiety Group (SFs, NACs) yielded a  $3 \times 2 \times 2$  factorial design. The participants’ median RTs in each of the six experimental conditions were used as dependent variables. The following predictions were tested: First, there should be an overall IOR effect, such that responses to invalid trials should be faster than responses to valid trials. Second, the IOR effect after spider cues should be reduced in the highly spider-fearful participants.

## Results and discussion

As in Experiment 1A, a significant IOR effect was observed,  $F(1, 46) = 125.62$ ,  $MSE = 582.20$ ,  $p < .001$ . As expected, invalidly cued targets were detected more quickly than validly cued ones (383 vs. 415 ms, see Table 6A). Again, the IOR effect was also significant after each cue type tested separately, all  $t_s(46) > 7.11$ ,  $p_s < .001$ . Moreover, level of spider fear had no effect whatsoever on RTs, indicated by a lack of significant main effects or interactions of the between-subjects factor, all  $F_s < 1.15$ , *ns*. Most importantly, after spider cues, both SFs and NACs showed significant IOR effects,  $t(22) = 4.68$ ,  $p < .001$  and  $t(23) = 7.63$ ,  $p < .001$ , respectively, which did not vary in size,  $F(1, 45) < 1$ .

To summarise, besides the expected IOR effect, no other noteworthy effect was found. Thus, even in highly spider fearfuls, the IOR effect was not reduced by a spider cue. It seems that the spider did not catch and hold attention strongly enough to affect inhibition of return, even when the spider was threatening and highly relevant to the participants. This result replicates that of Experiment 1, in which a larger, but unselected sample was tested.

TABLE 6A

Mean RTs and standard deviations (in parentheses) in milliseconds. Experiment 2: For spider, cross, and butterfly cues in spider fearfuls (SFs) and non-anxious controls (NACs)

	<i>Cue validity</i>			<i>Group</i>		
	<i>SF (n = 23): Cue type</i>			<i>NAC (n = 24): Cue type</i>		
	<i>Butterfly</i>	<i>Cross</i>	<i>Spider</i>	<i>Butterfly</i>	<i>Cross</i>	<i>Spider</i>
Valid	417 (43)	422 (49)	411 (36)	413 (47)	415 (46)	410 (43)
Invalid	380 (43)	386 (50)	384 (40)	382 (34)	387 (37)	377 (35)

TABLE 6B

Mean RTs and standard deviations (in parentheses) in milliseconds. Experiment 3: For angry, neutral, and smiling facial cues in Socially Anxious (SAs) and Non-Anxious Controls (NACs)

	<i>Cue validity</i>			<i>Group</i>		
	<i>SAs (n = 18): Cue type</i>			<i>NACs (n = 22): Cue type</i>		
	<i>Angry</i>	<i>Neutral</i>	<i>Smile</i>	<i>Angry</i>	<i>Neutral</i>	<i>Smile</i>
Valid	346 (32)	345 (34)	349 (34)	360 (42)	357 (37)	354 (40)
Invalid	337 (34)	336 (34)	339 (39)	345 (43)	348 (41)	344 (37)

### EXPERIMENT 3: IOR FOR FACIAL EXPRESSIONS IN THE SOCIALLY ANXIOUS

Experiment 3 was designed as a follow-up to Experiment 1B. In Experiment 3, we also employed emotional facial expressions as cues, but instead of testing an unselected sample, we tested two extreme groups, as in Experiment 2. Similar to the reasoning of the second experiment, we predicted that the IOR-reducing effect of an angry face cue should be particularly strong in individuals who are highly socially anxious. This expectation is based on several findings suggesting that the attentional bias for threatening social stimuli is most pronounced in these highly anxious individuals (Fox et al., 2001; Mogg, Philippot, & Bradley, 2004). Thus, if pictures of emotional facial expressions are indeed more relevant stimuli than black-and-white drawings of spiders, and if emotional facial expressions are indeed most threatening to the socially anxious, a reduction of the IOR effect should be observed in Experiment 3. In particular, we predicted that after an angry face cue, individuals high in social anxiety should show a marked reduction of the IOR effect. To test this prediction, we replicated Part 1B of Experiment 1 in a selected sample of highly socially anxious individuals who were compared to a group of non-anxious control participants. In all other aspects, Experiment 3 was a direct replication of Experiment 1B.

#### Methods

*Participants.* A selected sample of 18 highly socially anxious participants (SAs) and 22 matched non-anxious controls (NACs) participated in the experiment. All of them were students enrolled at Dresden University of Technology, Germany (see Table 7). An experimental session lasted for 20 minutes, for which participants received payment of €2 or course credit.

*Materials, apparatus, and procedure.* These were the same as in Experiment 1B, except for the following aspects: During lectures at Dresden University of Technology, students were asked to fill in the LSAS to screen their degree of social anxiety. They were invited to participate in the experiment if they scored below 14 points (NACs) or above 26 points (SAs). Upon arrival at the lab, they filled in the LSAS for a second time. If they scored within the same limits as on the screening day, they were allowed to continue the experiment. The remaining procedure was identical to the one described in Experiment 1B, except for the addition of the FDD (Kühner, 1997) to the set of questionnaires.

*Design and analyses.* Full combination of the within-subjects factors Cue Type (angry, neutral, smiling face) and Cue Validity (valid, invalid) with



TABLE 7

Means (M) and standard deviations (SD) of age, gender, and questionnaire scores for socially anxious (SAs) and non-anxious controls (NACs) in Experiment 3: Liebowitz Social Anxiety Scale (LSAS), trait version of the Spielberger State-Trait Anxiety Inventory (STAI-Trait) and Fragebogen zur Depressionsdiagnostik (FDD)

	Variables		Group	
	SA ( <i>n</i> = 18)		NAC ( <i>n</i> = 22)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (years)	24.2	(2.7)	25.0	(4.4)
Gender (% female)	77.8		68.8	
LSAS**	61.5	(16.7)	14.3	(7.8)
STAI-Trait**	46.1	(7.7)	31.4	(6.7)
FDD**	10.1	(5.1)	2.9	(3.2)

Note: \*\**p* < .001, two-tailed.

the between-subjects factor Anxiety Group (SFs, NACs) yielded a  $3 \times 2 \times 2$  factorial design. The participants' median RTs in each of the six experimental conditions were used as dependent variables. The following predictions were tested: First, there should be an overall IOR effect, such that responses to invalid trials should be faster than responses to valid trials. Second, the IOR effect after angry face cues should be significantly reduced in the highly socially anxious participants.

## Results and discussion

As in Experiment 1B, cue validity had a significant main effect on response latencies,  $F(1, 38) = 20.26$ ,  $MSE = 309.32$ ,  $p < .001$ . Again, this was due to an IOR effect: Invalidly cued targets were detected more quickly than validly cued ones (342 vs. 352 ms, see Table 6B). And again, individual analyses of the IOR effects for the three different cue types revealed that it was significant for each cue, all  $t_s(39) > 2.55$ ,  $ps < .02$ . As before, neither did cue type yield a main effect,  $F(2, 76) \leq 1$ ,  $MSE = 209.95$ , nor did it interact with cue validity,  $F(2, 76) < 1$ ,  $MSE = 268.50$ . The same was true for the factor anxiety group, which yielded neither a main effect on RTs nor any interaction (all  $F_s < 1.2$ ,  $MSE < 210$ ,  $p > .05$ ). Most importantly, after angry facial cues, the IOR effect exhibited by SAs did not differ from the one shown by NACs,  $F(1, 38) < 1$ .

To summarise, SAs and NACs did not react differently to the emotional face cues or the validity of the cues, and the IOR effect after angry face cues was not reduced in SAs. As in Experiment 1B, the manipulations resulted in a stable IOR effect, observable in both groups and after all cues.

## GENERAL DISCUSSION

In three experiments, the effect of biologically relevant cues and threatening cues on inhibition of return was investigated. Pictures denoting objects of supposedly evolutionary relevance served as cues for a neutral target that had to be localised after a delay of 550 ms from cue onset. In Experiments 1A and 2, the targets were cued validly and invalidly by drawings of spiders, butterflies, and crosses. An unselected sample of students (Part 1A of Experiment 1) as well as selected participants who were either highly spider fearful or not afraid of spiders (Experiment 2) participated in this visual cueing task. In Experiments 1 and 3, the cues were photographs of individuals looking angry, neutral, or smiling. These cues were presented to an unselected group of participants (Part 1B of Experiment 1), as well as to selected participants who were either highly socially anxious or non-anxious (Experiment 3). The experiments were designed to test the prediction that the IOR effect (faster responses to invalidly cued targets than to validly cued ones) would be reduced for anxiety-evoking stimuli such as spiders and angry faces (Experiment 1). Furthermore, the reduction should be particularly large in fearful individuals for whom these stimuli are highly threatening, that is, spider-fearful and socially anxious individuals, respectively (Experiments 2 and 3). The results of these three experiments were fairly clear cut, and not in line with the predictions at all: In all experimental conditions of all experiments, invalid cueing facilitated responses compared to valid cueing, yielding reliable IOR effects. Neither type of cue nor fear level of the participants had any impact on the IOR effect whatsoever.

Previous studies of individual variables that may affect inhibition of return have shown that the effect may indeed be reduced by different kinds of psychopathology. For instance, Roelofs et al. (2003) found that patients with conversion paresis showed a diminished inhibition of return, and Burdick (2003) reported that bipolar depression was related to decreases in inhibition of return. Nelson, Early, and Haller (1993) found reduced IOR in patients with obsessive-compulsive disorder, and speculated that these patients lack inhibitory attentional processes. However, Moritz and von Mühlhelen (2005) could not confirm these findings of reduced IOR: Both patients and control participants consistently presented IOR effects, and the magnitude of the effect was not moderated by symptom severity, comorbid depression, nor medication use. In all of these studies, however, neutral cues and targets were used, in order to investigate the alteration of IOR in general. Thus, the supposedly contradictory influence of threat detection on an automatic attentional process could not be assessed.

To the best of our knowledge, only four published studies addressed the question whether the general relevance of a cue or its individual threat value might influence the magnitude of IOR.

While Fox et al. (2002) concluded from their study that angry faces serving as invalid cues do indeed eliminate the IOR effect in highly anxious participants, Taylor and Therrien (2005) found that the IOR effect was not influenced by neutral faces, neither when employed as cues nor as targets. Similarly, Stoyanova, Pratt, and Anderson (2007) found that neither fearful face cues, neutral face cues, nor luminance matched cues changed the magnitude of the observed IOR. In a slightly different version of the task, Theeuwes and van der Stigchel (2006) investigated the occurrence of IOR after simultaneous presentation of (neutral) face cues and household objects. The results revealed that only faces seemed to capture attention such that an IOR arose. Thus, the occurrence of the IOR effect instead of its reduction was taken as evidence for an attentional bias. Since no IOR occurred in response to household objects, it was impossible to tell whether the inhibition of return was reduced on the location of the formerly presented face. The different methodology of especially the latter study renders a comparison rather difficult.

Our results coincide well with those of Taylor and Therrien (2005) and Stoyanova and colleagues (2007) even though they did not employ threatening faces. As in their study, we found no influence of the type of facial expression on the IOR effect, neither in an unselected sample nor in socially anxious participants. In addition to the facial cues, we found that the IOR effect was also resistant against threat-related animal cues, namely spider pictures, both in an unselected sample and in highly spider fearfuls. Thus, in four tasks, IOR effects have proven to be resistant against effects of emotionally valenced, threatening cues. One might object, however, that despite the frequent replications, the statistical power of each individual experiment might have been insufficient. Therefore, we increased statistical power by combining the data of Experiment 1a and Experiment 2. With this sample of 100 participants, we again computed correlations of the SAS and FSQ scores with the IOR effect for spider cues. Please note that these correlations are artificially inflated because Experiment 2 contained only extreme groups with regard to fear of spiders. Nevertheless, they remained low and insignificant (SAS:  $r = -.02$ , *ns*; FSQ:  $r = -.06$ , *ns*). The same result was observed when the data of Experiment 1b and Experiment 3 were combined. Even with this sample of 94 participants, the inflated correlation of the LSAS scores with the IOR effects for angry faces remained insignificant ( $r = -.08$ , *ns*). Therefore, we are quite confident that our findings cannot be explained by a lack of statistical power. Moreover, the fact that spiders as well as smiling and angry faces in our study, and fearful faces in the Stoyanova et al. study (2007) failed to affect the IOR, suggests that the IOR is resistant to a variety of emotional stimuli.

The finding that threatening stimuli had no effect on IOR stands in contrast to the effects that have been observed many times with other

experimental paradigms, including the dot-probe task (e.g., Mogg et al., 2004), disengagement tasks (Fox et al., 2002), and free-viewing tasks (e.g., Rinck & Becker, 2006). In these tasks, attentional biases of highly fearful individuals were observed, suggesting that threatening stimuli (e.g., spiders or angry faces) capture and hold attention, such that fearful individuals find it difficult to disengage their attention from these stimuli. Thus, the question arises why attentional biases have been observed for these tasks and processes, but not for tasks addressing IOR. One potential explanation might be that the stimulus materials used in the present experiments are not suitable for eliciting the expected effects because line drawings and black and white photographs might not be ecologically valid enough to represent the desired threat. This is rather unlikely, however, because many studies have employed comparable materials, and the very *same* materials have successfully evoked biases in other studies, for instance, automatic avoidance tendencies in social phobics (Heuer, Rinck, & Becker, 2007) or affective priming in spider fearfuls (Becker, Lange, Reinecke, & Rinck, 2006), respectively. Nevertheless, we are aware that a more direct, maybe even physiological, validation of the threat potential of the stimuli would have been more elegant.

The lack of a theoretical framework in which a hypothetical interference of attentional bias and IOR can be placed, puts forward some theoretical and methodological questions. For example, it could be argued that threat-related stimuli could emphatically stress a location as already processed, rather than undermining the inhibition process. This would lead to a more exaggerated IOR. Evolutionarily, this makes no sense, though; since one would rather want to attend to immanent danger than avoid scanning its location again. Besides that, in highly anxious participants, attentional biases towards threat rather than away from it have been shown quite consistently.

Compared to other studies (e.g., Fox et al., 2002), one might believe that methodological deviations in our design could account for the lack of threat influences on IOR. First, we have used a target detection (“now”) task rather than a target classification (“what”) or target position (“where”) task. It could be that increased cognitive load during a categorisation decision makes vigilance processes more vulnerable to distraction/attraction by threat, compared to the simpler decision about a target’s location, or the even simpler decision that *something* happened. In an extensive review, Schooten (2007); chapter 1) listed an impressive number of studies using diverging designs, which nevertheless reported differential processing of threat cues/targets. Mogg and Bradley (1999) directly compared classification and position tasks and found that advantages for threat processing were equally strong in both designs. Additionally, Salemkink, van den Hout, and Kindt (2007) compared a categorisation and a detection task and concluded that the latter might even be superior in detecting preferential processing of

threat-related words (compare also: Wenzel & Holt, 1999). Therefore, we are confident that the probe-detection procedure we employed is useful for detecting process biases for threat-related stimuli, given that there are any.

One might also object that our results are due to the fact that the presentation time of our cues (100 ms) was shorter than in many other studies. Bradley, Mogg, Falla, and Hamilton (1998) justly argue that presenting cues for 500 ms would facilitate comparability of findings from different studies. However, numerous studies have shown that presentation times of 200, 100 and even 17 ms are sufficient for revealing differential threat processing in these paradigms (Cooper & Langton, 2006; Koster, Verschuere, Crombez, & Van-Damme, 2005; Mogg & Bradley, 2002, 2006).

Further, unlike Fox and colleagues (2002), and also Taylor and Therrien (2005), we did not use an intermediate cue to redirect attention from the cued location back to the fixation point and make a subsequent shifting to that locus a “real” return. If it were the case that, without such a procedure, attention had never moved from the (invalidly) cued location, IOR effects would never have occurred (compare: Lupianez et al., 2006). Thus, if the focus of attention did indeed remain on the location of the cue, valid trials would always be faster than invalid trials, independent of the length of the SOA. However, Stoyanova et al. (2007) have shown in two experiments that IOR was not influenced by fearful faces, neither with nor without an intermediate redirection of attention (see also Footnote 1). Additionally, one could argue that non-anxious controls have a tendency to avoid attention to threatening stimuli (e.g., Mansell, Clark, Ehlers, & Chen, 1999) and that, consequently, IOR should be inflated. But if that were the case, correlations between degree of anxiety, or group differences would have been observed.

A major concern, however, is that the observed IOR could also be easily attributed to forward masking. Since (visual) attention to a target often seems to be corrupted when preceded by another stimulus in the same location, it is possible that valid trials are generally disadvantaged over invalid trials. If that was a stable effect, consequences of threat stimuli might be overwritten by the effect of forward masking. To exclude such an explanation, it would have been necessary to present the target on valid trials close to, but not *on* the location of the cue. Nevertheless, the large IOR literature suggests that both procedures lead to effects attributable to IOR (compare Footnote 1). Berlucchi (2006) suggested that both single and bilateral cuing bring forth inhibition, with the latter not being explicable by forward masking. More importantly, he refers to studies by Possamai (1986), and Tassinari, Biscaldi, Marzi, and Berlucchi (1989), who also explored RTs to *centrally* presented cues and targets. They all assumed that the observed inhibition was merely due to sensory “bottom-up” influence, meaning that some low-level cue property initiates (local) inhibition, not forward masking as a consequence of stimulus sequence (compare: Berlucchi, 2006). Conse-

quently, this could also explain why the presentation of threatening cues in our experiments did not interfere with such an inhibitory process: Stimulus recognition or stimulus valence are determined “top-down”, that is, based on individual experiences. If energy changes in the visuospatial field are detected and lead to subsequent inhibition of a locus, the valence of a cue might not “get the chance to make a difference”.

A last potential explanation might be that, compared to other experimental paradigms, IOR tasks have rarely been used. Thus, the boundary conditions for affective modulations of the IOR effect have not been identified yet, even though they might exist (but see Footnote 1). Until these are identified, however, we have to conclude that inhibition of return is a surprisingly stable phenomenon, unimpressed by affective valence of the cues. IOR might indeed be an evolved mechanism that promotes novelty in one’s visual field (Klein & MacInnes, 1999). This mechanism may be so strong that it is not easily overruled by other evolutionary relevant functions, such as the detection of potentially harmful stimuli in the environment. Future research will have to show whether this is indeed the case with different stimuli and different individuals.

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## REFERENCES

- Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, 4, 561–571.
- Becker, E. S., Lange, W.-G., Reinecke, A., & Rinck, M. (2006). *Affective priming in spider fearfuls: A dissociation between fast and slow reactions*. Manuscript submitted for publication.
- Berlucchi, G. (2006). Inhibition of return: A phenomenon in search of a mechanism and a better name. *Cognitive Neuropsychology*, 23(7), 1065–1074.
- Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, L. R. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition and Emotion*, 12(6), 737–753.
- Burdick, K. E. (2003). Attention mechanisms in bipolar depression. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, 63(9-B), 4063.
- Cooper, R. M., & Langton, S. R. H. (2006). Attentional bias to angry faces using the dot-probe task? It depends when you look for it. *Behaviour Research and Therapy*, 44(9), 1321–1329.
- Derogatis, L. R. (1994). *SCL-90-R: Administration, scoring, and procedures manual* (3rd ed.). Minneapolis, MN: Derogatis.
- Eysenck, M. W. (1992). *Anxiety: The cognitive perspective*. Hove, UK: Lawrence Erlbaum Associates, Ltd.

- 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*(4), 681–700.
- Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed disengagement from emotional faces. *Cognition and Emotion*, *16*(3), 355–379.
- Hansen, C. H., & Hansen, R. D. (1988). Finding the face in the crowd: An anger superiority effect. *Journal of Personality and Social Psychology*, *54*(6), 917–924.
- Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. *Trends in Cognitive Sciences*, *4*(6), 223–233.
- Herrmann, M. J., Ehlis, A. C., Muehlberger, A., & Fallgatter, A. J. (2005). Source localization of early stages of face processing. *Brain Topography*, *18*(2), 77–85.
- Heuer, K., Rinck, M., & Becker, E. S. (2007). Avoidance of emotional facial expressions in social anxiety: The Approach–Avoidance Task. *Behaviour Research and Therapy*, *45*, 2990–3001.
- Klein, R. M., & MacInnes, W. J. (1999). Inhibition of return is a foraging facilitator in visual search. *Psychological Science*, *10*(4), 346–352.
- Klein, R. M., & Taylor, T. L. (1994). Categories of cognitive inhibition with reference to attention. In D. Dagenbach & T. H. Carr (Eds.), *Inhibitory processes in attention, memory, and language* (pp. 113–150). San Diego, CA: Academic Press.
- Koster, E. H. W., Crombez, G., Verschuere, B., Damme, S., & Wiersema, J. R. (2006). Components of attentional bias to threat in high trait anxiety: Facilitated engagement, impaired disengagement, and attentional avoidance. *Behaviour Research and Therapy*, *44*(12), 1757–1771.
- Koster, E. H. W., Verschuere, B., Crombez, G., & Van-Damme, S. (2005). Time-course of attention for threatening pictures in high and low trait anxiety. *Behaviour Research and Therapy*, *43*(8), 1087–1098.
- Kühner, C. (1997). *Fragebogen zur Depressionsdiagnostik nach DSM-IV (FDD-DSM-IV)*. Göttingen, Germany: Hogrefe.
- LeDoux, J. E. (1996). *The emotional brain: The mysterious underpinnings of emotional life*. New York: Simon & Schuster.
- Liebowitz, M. R. (1987). Social phobia. *Modern Problems of Pharmacopsychiatry*, *22*, 141–173.
- Lundh, L. G., & Oest, L. G. (1996). Recognition bias for critical faces in social phobias. *Behaviour Research and Therapy*, *34*(10), 787–794.
- Lupianez, J., Klein, R. M., & Bartolomeo, P. (2006). Inhibition of return: Twenty years after. *Cognitive Neuropsychology*, *23*(7), 1003–1014.
- Mansell, W., Clark, D. M., Ehlers, A., & Chen, Y. P. (1999). Social anxiety and attention away from emotional faces. *Cognition and Emotion*, *13*(6), 673–690.
- Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology*, *1*(1), 167–195.
- McAuliffe, J., & Pratt, J. (2005). The role of temporal and spatial factors in the covert orienting of visual attention tasks. *Psychological Research/ Psychologische Forschung*, *69*(4), 285–291.
- Mineka, S., & Öhman, A. (2002). Phobias and preparedness: The selective, automatic, and encapsulated nature of fear. *Biological Psychiatry*, *51*(9), 927–937.
- Mogg, K., & Bradley, B. (1999). Some methodological issues in assessing attentional biases for threatening faces in anxiety: A replication study using a modified version of the probe detection task. *Behaviour Research and Therapy*, *37*, 595–604.
- Mogg, K., & Bradley, B. (2002). Selective orienting of attention to masked threat faces in social anxiety. *Behaviour Research and Therapy*, *40*, 1403–1414.
- Mogg, K., & Bradley, B. P. (2006). Time course of attentional bias for fear-relevant pictures in spider-fearful individuals. *Behaviour Research and Therapy*, *44*(9), 1241–1250.
- Mogg, K., Philippot, P., & Bradley, B. P. (2004). Selective attention to angry faces in clinical social phobia. *Journal of Abnormal Psychology*, *113*, 160–165.

- Moritz, S., & von Mühlhagen, A. (2005). Inhibition of return in patients with obsessive-compulsive disorder. *Journal of Anxiety Disorders, 19*(1), 117–126.
- Nelson, E., Early, T. S., & Haller, J. W. (1993). Visual attention in obsessive-compulsive disorder. *Psychiatry Research, 49*(2), 183–196.
- Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behaviour. In R. J. Davidson, G. E. Schwartz, & D. Shapiro (Eds.), *Consciousness and self-regulation: Advances in research and theory* (Vol. 4). New York: Plenum Press.
- Oakman, J., Van-Ameringen, M., Mancini, C., & Farvolden, P. (2003). A confirmatory factor analysis of a self-report version of the Liebowitz Social Anxiety Scale. *Journal of Clinical Psychology, 59*(1), 149–161.
- Öhman, A. (1993). Fear and anxiety as emotional phenomena: Clinical phenomenology, evolutionary perspectives, and information-processing mechanisms. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 511–536). New York: Guilford Press.
- Öhman, A. (2002). Automaticity and the amygdala: Nonconscious responses to emotional faces. *Current Directions in Psychological Science, 11*(2), 62–66.
- Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130*(3), 466–478.
- Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology, 80*(3), 381–396.
- Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review, 108*(3), 483–522.
- Öhman, A., & Soares, J. J. (1993). On the automatic nature of phobic fear: Conditioned electrodermal responses to masked fear-relevant stimuli. *Journal of Abnormal Psychology, 102*(1), 121–132.
- Pardo, J. V., Pardo, P. J., Janer, K. W., & Raichle, M. E. W. (1990). The anterior cingulate cortex mediates processing selection in the Stroop attentional conflict paradigm. *Proceedings of the National Academy of Science of the USA, 87*, 256–259.
- Petersen, W. E., Fox, P. T., Miezen, F. M., & Raichle, M. E. W. (1988). Modulation of cortical visual responses by direction of spatial attention measured by PET. *Association for Research in Vision and Ophthalmology, Abstracts, 22*.
- Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32*(1), 3–25.
- Posner, M. I., & Cohen, Y. (1984). Components of visual orienting. In H. Bouma & D. Bouwhuis (Eds.), *Attention and performance X: Control of language processes* (pp. 531–556). Hove, UK: Lawrence Erlbaum Associates, Ltd.
- Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13*, 25–42.
- Posner, M. I., Rafal, R. D., Choate, L. S., & Vaughan, J. (1985). Inhibition of return: Neural basis and function. *Cognitive Neuropsychology, 2*(3), 211–228.
- Possamai, C. A. (1986). Relationship between inhibition and facilitation following a visual cue. *Acta Psychologica, 61*(3), 243–258.
- Pratt, J., & Fischer, M. H. (2002). Examining the role of the fixation cue in inhibition of return. *Canadian Journal of Experimental Psychology, 56*(4), 294–301.
- Rinck, M., & Becker, E. S. (2006). Spider fearful individuals attend to threat, then quickly avoid it: Evidence from eye movements. *Journal of Abnormal Psychology, 115*(2), 231–238.
- Rinck, M., Bundschuh, S., Engler, S., Müller, A., Wissmann, J., Ellwart, T., et al. (2002). Reliability and validity of German versions of three instruments measuring fear of spiders/Reliabilität und Validität dreier Instrumente zur Messung von Angst vor Spinnen. *Diagnostica, 48*(3), 141–149.



- Roelofs, K., van Galen, G. P., Eling, P., Keijsers, G. P. J., & Hoogduin, C. A. L. (2003). Endogenous and exogenous attention in patients with conversion paresis. *Cognitive Neuropsychology*, *20*(8), 733–745.
- Salemink, E., van den Hout, M. A., & Kindt, M. (2007). Selective attention and threat: Quick orienting versus slow disengagement and two versions of the dot probe task. *Behaviour Research and Therapy*, *45*(3), 607–615.
- Samuel, A. G., & Kat, D. (2003). Inhibition of return: A graphical meta-analysis of its time course and an empirical test of its temporal and spatial properties. *Psychonomic Bulletin and Review*, *10*(4), 897–906.
- Schooten, M. G. S. (2007). *Preferential processing in anxiety: Selective attention & spatial affective Simon effects*. [Doctoral Dissertation] Maastricht, The Netherlands: Universitaire Pers.
- Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologist Press.
- Stoyanova, R. S., Pratt, J., & Anderson, A. K. (2007). Inhibition of return to social signals of fear. *Emotion*, *7*(1), 49–56.
- Szymanski, J., & O'Donohue, W. (1995). Fear of Spiders Questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry*, *26*(1), 31–34.
- Tassinari, G., Biscaldi, M., Marzi, C. A., & Berlucchi, G. (1989). Ipsilateral inhibition and contralateral facilitation of simple reaction time to non-foveal visual targets from non-informative visual cues. *Acta Psychologica*, *70*(3), 267–291.
- Taylor, T. L., & Klein, R. M. (1998). On the causes and effects of inhibition of return. *Psychonomic Bulletin and Review*, *5*(4), 625–643.
- Taylor, T. L., & Klein, R. M. (2000). Visual and motor effects in inhibition of return. *Journal of Experimental Psychology: Human Perception and Performance*, *26*(5), 1639–1656.
- Taylor, T. L., & Therrien, M. E. (2005). Inhibition of return for faces. *Perception and Psychophysics*, *67*(8), 1414–1422.
- Theeuwes, J., & van der Stigchel, S. (2006). Faces capture attention: Evidence from inhibition of return. *Visual Cognition*, *13*(6), 657–665.
- Vuilleumier, P. (2002). Facial expression and selective attention. *Current Opinion in Psychiatry*, *15*(3), 291–300.
- Vuilleumier, P., & Pourtois, G. (2007). Distributed and interactive brain mechanisms during emotion face perception: Evidence from functional neuroimaging. *Neuropsychologia*, *45*(1), 174–194.
- Wenzel, A., & Holt, C. (1999). Brief report. Dot probe performance in two specific phobias. *British Journal of Clinical Psychology*, *38*, 407–410.
- Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1988). *Cognitive psychology and emotional disorders*. Chichester, UK: Wiley.
- Williams, P., & Tarr, M. J. (1998). RSVP: Experimental control software for MacOS. [Computer software and manual]. (Available from <http://www.tarrlab.org/rsvp> – Retrieved 2 March 2004)
- Yantis, S. (1996). Attentional capture in vision. In A. F. Kramer, M. G. H. Coles, & G. D. Logan (Eds.), *Converging operations in the study of visual selective attention* (pp. 45–76). Washington, DC: American Psychological Association.
- Zimmerman, M., Coryell, W., Corenthal, C., & Wilson, S. (1986). A self-report scale to diagnose major depressive disorder. *Archives of General Psychiatry*, *43*(11), 1076–1081.