# Attentional capture and trait anxiety: Evidence from inhibition of return

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ABSTRACT

Attentional biases regarding attentional capture by threat-related stimuli in anxious people were investigated by using a standard spatial cueing procedure suitable to measure inhibition of return (IOR). In two experiments, participants categorized the emotional valence of either emotional (positive and negative words) or non-emotional (neutral words in both experiments and sets of 'xxx' in Experiment 1) targets that were preceded by a peripheral non-predictive cue. The typical IOR effect (slower responses for words presented at previously cued locations) was observed for non-emotional and positive stimuli, with similar results being observed for both low and high trait anxiety groups. For negative stimuli, however, the high trait anxiety group did not show the IOR effect, while it was present in the low trait anxiety group. This general pattern of results suggests that, in individual with high trait anxiety, threatening stimuli can capture attention at the locations whether attentional capture is hindered by other cognitive effects such as IOR.

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## 1. Introduction

Many theorists argue that fear is implicated in adaptive cognitive and physiological functions (LeDoux, 1996). It is associated with activation of defensive systems involved in detecting and responding to danger, which includes attentional mechanisms to facilitate the fast and accurate perception of threatening stimuli appearing in the environment (Lang, Davis, & Öhman, 2000). From an evolutionary perspective, the fast and accurate detection of threatening stimuli has a survival value, so that those who were able to detect and elude danger would pass these survival abilities on to their offspring. However, the hyperactivation of the defense system, which mediates the fear reaction, when circumstances are not dangerous or during too much time, may also lead to emotional disorders of anxiety, such as when the presence of threatening stimuli interferes with the requirements of other goals (Mathews & MacLeod, 1985). Many models of anxiety have put forward that attention is biased towards potentially threatening information in people with high anxiety and these biases may be involved in the origin and maintenance of anxiety disorders (Eysenck, 1992; Mathews & MacLeod, 1994; Williams, Watts, MacLeod, & Mathews, 1997). Other theorists (Fox, Russo, & Dutton, 2002), suggest that anxiety

problems emerge from biases in *disengaging* attentional resources from threatening stimuli, once they have been detected.

Two prominent strategies have been used to study these threat related biases. The first is to show that attending to threat-related stimuli can improve task performance, as in the dot probe task (e.g., MacLeod, Mathews, & Tata, 1986). In contrast, the second strategy is to examine that attending to threat-related stimuli can interfere with task performance, as in Stroop interference (e.g., Williams, Mathews, & MacLeod, 1996).

However, results from studies using these strategies can be interpreted in two ways: either as negative or threat-related stimuli *engaging* attention more readily than neutral stimuli in people with high anxiety, or as increased difficulty in this population to shift or *disengage* attention from threat-related stimuli (Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschuere, & De Houwer, 2004; Stormark, Nordy, & Hugdahl, 1995). Differentiating between these two hypotheses is important for understanding anxiety disorders (for more reasons, see Koster et al., 2004).

A classical psychological paradigm used to dissociate between attentional operations (i.e., attention capture or engagement, movement and disengagement) has been the cost-benefit paradigm with exogenous cues (Posner, 1980). This task was designed to investigate spatial orienting of visual attention, which can be broken down into three elementary operations including: (1) interruption of ongoing activity in order to *disengage* from the current focus of attention, (2) *moving attention* to a new location, and (3) *engaging* attention to the new stimulus location (Posner, Inhoff, Friedrich, & Cohen, 1987). This paradigm involves a target stimulus that is preceded by a brief cue. Participants have to

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respond only to the target which typically can appear in one of two peripheral boxes, one to the right and to the other to the left of fixation.

When cue and target appear in the same location (valid trials) participants are faster and more precise responding to targets as compared to when cue and target appear in the opposite location (invalid trials). This is the so-called 'facilitation effect,' which is thought to reflect both a benefit in processing of valid trials due to the involuntary, reflexive shift of attention towards the source of stimulation, and a cost in invalid trials due to the need to disengage attention from the cued location in order to orient it to the opposite target location.

When the target does not appear at the location of the cue more often than chance, the described effect appears only with short stimulus onset asynchronies (SOA) between cue and target. In fact, with long SOAs participants are slower and less precise responding to targets in valid trials compared to invalid trials. This has been argued to reflect a bias against returning attention to previously explored locations (Klein, 2000), or a cost in attention being captured where it was already captured before (Lupiáñez et al., 2004; Lupiáñez, Ruz, Funes, & Milliken, 2007). The long SOA effect is referred to as *inhibition of return* (IOR) (for a review of the IOR effect, see Klein, 2000). The SOA at which IOR first appears depends on task demands. For example, when a detection task is used the IOR begins at cue-target SOA of 300–500 ms, whereas with discrimination tasks IOR is not observed at SOAs shorter than 700–1000 ms (Lupiáñez, Milán, Tornay, Madrid, & Tudela, 1997).

Using this paradigm with short SOAs, researchers have manipulated the emotional valence of the cue to investigate whether the attentional biases in anxiety are due to facilitated engagement towards threat related stimuli (attentional *capture*), or to a difficulty in disengaging attention from threatening stimuli (*disengaging* attention). Both pictorial stimuli (Fox et al., 2001, 2002) and word stimuli (Broomfield & Turpin, 2005) have been used as cue. Results from recent studies have supported the *disengaging hypothesis* because negative cues only influenced response times on invalid trials, where attention has to disengage from the cued location. From these results it has been concluded that the described attentional bias observed in people with high trait and state anxiety involves a specific difficulty in disengaging attention from the location of threatening stimuli (Broomfield & Turpin, 2005; Fox et al., 2001; Yiend & Mathews, 2001).

When parameters of the task are modified (i.e., long SOA) to observe IOR instead of facilitation effects it has been observed that the IOR effect shown by anxious people with non-threat neutral cues disappears with threat-related cues (Fox et al., 2002), whereas controls show similar IOR for both types of cues (Stoyanova, Pratt, & Anderson, 2007). Reduction or elimination of the IOR effect with threatening cues is thought to reflect the reluctance of anxious people to disengage attention from negative stimuli. If attention is not disengaged from the cued location, the IOR effect is not present. Taken together evidence seems to support the disengaging hypothesis. However, rather than being a general conclusion, we think this supporting evidence might be specific to the paradigm being used. Therefore, the main goal of the current study was to investigate the attentional capture hypothesis, by means of a different logic. Instead of manipulating the emotional valence of the *cue*, we manipulated the emotional valence of the *target*, in a standard spatial cueing procedure suitable to observe IOR effects. The target stimuli had neutral, positive or negative valence, and participants with high vs. low levels of anxiety were to categorize them as being either emotional or non-emotional.

To our knowledge IOR has only been reported using a categorization task with words (Chasteen & Pratt, 1999), and the effect is hard to get in difficult task designs without changing the standard paradigm (Lupiáñez, Milliken, Solano, Weaver, &

Tipper, 2001). Therefore, several modifications were incorporated into the design of the present experiment. These included: (1) the SOA was long enough as to observe IOR in a categorization task (1000 ms), (2) a shorter SOA (100 ms) was also included to provide complete spatial and temporal uncertainty (50% valid trials and 50% invalid trials; 50% short SOA, and 50% long SOA), as previous work in our lab has shown that the manipulation of long and short SOAs within the same block is most appropriate to observe IOR, (3) the presentation of a second *cue* [1] at the Fixation Point (*central flash or cue back*) on long SOA trials, and (4) eccentricity of the target and the cue from the central fixation point was also manipulated.

We expected to find evidence favoring the *attentional capture hypothesis*. The logic was the following: On the one hand we know IOR represents a reduced attentional capture for targets appearing at previously cued locations (i.e., a bias against attention being captured again at or returning to this location, Lupiáñez et al., 2004). On the other hand, the *attentional capture hypothesis* of anxiety proposes that negative stimuli capture attention more effectively than neutral or positive stimuli in anxious people. Therefore, when highly anxious people are confronted with a negative stimulus as a target, we might expect it to capture attention and overcome the IOR cognitive bias. Thus, in the present study, reduction or elimination of the IOR effect for negative stimuli in highly anxious people would support the *attentional capture hypothesis*.

We expected low-anxious participants to be slower and make more errors for all types of target on valid trials, as compared to invalid ones, thus showing the IOR effect, at least when the central flash is presented. However, we expected the IOR effect to disappear or be attenuated for negative targets in high trait anxious participants, while being present for the other types of target.

## 2. Experiment 1

### 2.1. Method

#### 2.1.1. Participants

Three hundred and ten students from a first year psychology course at the University of Granada were recruited to complete the Spielberger trait–anxiety scale (STAI-T; Spielberger, Gorsuch, & Lushene, 1994). Sixty-four participants (forty-eight females and sixteen males) were selected from this group according to their scores on the STAI-T and assigned to one of two groups. Participants in the 'high trait anxiety' group (HA; twenty-six females and six males) were selected on the base of their high anxiety score (above the 75th percentile according to the norms from the Spanish population). Participants in the 'low trait anxiety' group (LA; twenty two females and ten males) were selected for having a low score on the scale (below the 25th percentile). Participants within each anxiety group were randomly assigned to either the Low eccentricity (twenty-two females and ten males) vs. High eccentricity (twenty-six females and six males) condition or the Central-Flash (twenty-two females and ten males) vs. No-Central-Flash (twenty-six females and six males) condition.

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[1] It should be noted that the seminal paper by Posner and Cohen (1984) used a flash that was presented at fixation before the target, assuming that IOR would not appear if attention is not first disengaged from the cued location. In fact a *central flash* was used by Chasteen and Pratt (1999) in their categorization tasks in order to get IOR. However in detection tasks this central flash is not a necessary condition to see IOR (Maylor, 1985; Lupiáñez et al., 1997, 2001). In simple discrimination tasks the central flash is neither necessary, although the effect only appears at a longer than usual SOA (Lupiáñez et al., 1997). On the other hand, regarding the degree of eccentricity, this variable has been shown to be important in some research with children (Harmon, Posner, & Rothbart, 1992), where the IOR effect only is observed at some eccentricities. Therefore, we wanted to explore whether this variable is important in adults as well.