Acta Psychologica 141 (2012) 281–286

Contents lists available at SciVerse ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/ locate/actpsy

Inhibition of return at foveal and extrafoveal locations: Re-assessing the evidence

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ARTICLE INFO

Article history:
Received 14 March 2012
Received in revised form 11 September 2012
Accepted 18 September 2012
Available online 13 October 2012

PsycINFO classification:
2346
2323

Keywords:
Reaction time
Attention
Inhibition of return
Fovea
Cue
Target

ABSTRACT

Inhibition of return (IOR) has been described as a hallmark of externally controlled orienting of attention using extrafoveal cues and targets. This paper describes an IOR like inhibition of reaction time for the detection of targets at the fovea that cannot be explained by shift of covert attention. This foveal RT inhibition adds to the evidence that challenges the view of IOR-like phenomena as obligatory expressions of orienting and attentional control.

1. Introduction

The phenomenon called inhibition of return (IOR) is supposed to reflect a bias against reorienting attention to a recently stimulated visual location, in the interest of a more efficient inspection of the entire visual field. In its simplest form, the IOR experimental paradigm involves the mere detection of light targets at peripheral visual field locations that may or may not have been recently occupied by light stimuli (cues) unpredictive of target location. Detection RT is assumed to undergo a short lived (<200 ms) facilitation at the cued location, due to an automatic capture of attention by the cue, followed by a long lasting (>2 s) RT inhibition, indexing IOR and presumably caused by the re-centering of attention hence its removal from the cued location. RT facilitation and inhibition are recorded while the eyes remain fixated on a central point, so that the presumed shifts of attention to and from the cued location are thought to occur covertly, first by a dissociation and then a realignment between the attentional focus and the line of gaze (Posner, Rafal, Choate, & Vaughan, 1985).

This canonical account of attentional orienting in IOR paradigms can be questioned on various grounds (e.g. Berlucchi, 2006; Lupiáñez, 2010), especially because RT inhibition appears to persist even when covert attention is voluntarily maintained at the cued location during target presentation (Berger, Henik, & Rafal, 2005; Berlucchi, Chelazzi, & Tassinari, 2000; Lupiáñez et al., 2004; Rafal, Davies, & Lauder, 2006). In this vein, there is very little evidence on RT modulations observable when cues and targets are presented to the fovea during active fixation, i.e. in conditions which at first glance do not seem liable to promote shifts of attention.

To the best of our knowledge only four studies have used foveal cues and targets in experimental settings common to the typical IOR paradigms which involve the detection of extrafoveal targets after spatially uninformative cues (Maylor & Hockey, 1985; Possamai, 1986; Rafal et al., 2006; Tassinari, Biscaldi, Marzi, & Berlucchi, 1989). The general message from these studies is that foveal cues generally increase RT for the detection of foveal targets, but it is not known whether such inhibition is preceded by RT facilitation, as in the case of the biphasic facilitation–inhibition pattern observed with extrafoveal cues and targets. Three of these papers have indeed used cue-target onset asynchronies (CTOAs) too long to allow the ascertainment of an RT facilitation preceding RT inhibition (Maylor & Hockey, 1985; Rafal et al., 2006; Tassinari et al., 1989), and in two of them (Maylor & Hockey, 1985; Rafal et al., 2006) the experimental paradigms included additional procedures which complicate the comparison with basic IOR paradigms. In the fourth paper there was inhibition at the fovea even at the short CTOAs associated with an early RT facilitation at extrafoveal locations, but foveal RT

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0001-6918/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.actpsy.2012.09.012

inhibition was not statistically significant at both short and long CTOAs (Possamai, 1986).

The present study was aimed at re-exploring the influence of foveal cues on RT for the detection of foveal targets in a basic IOR paradigm, and at inferring possible attentional and non-attentional mechanisms underlying the observed effects. The study was carried out in accordance with the guidelines of the Declaration of Helsinki.

2. Experiment 1

In this experiment we presented targets after spatially uninformative cues in an IOR paradigm with three possible stimulus locations, one central and two lateral, one on the left and the other on the right. Three CTOAs were used (150, 360 and 570 ms) because the first corresponds to the asymptote of facilitation and the other two are well into the inhibition phase typically observed at extrafoveal locations (e.g. Lupiáñez, 2010).

2.1. Methods

2.1.1. Participants

Forty individuals (17 males) ranging in age from 20 to 55 years participated. All of them were right-handed, had normal or corrected-to-normal visual acuity and normal colour perception, did not suffer from neurological or psychiatric problems, and were naïve as to the purpose of the study.

2.1.2. Apparatus and stimuli

The experiment was run in E-Prime (Psychology Software Tools, Inc.) using an IBM compatible notebook. Stimuli were displayed on the 14-inch monitor of the notebook. The visual display consisted of a white fixation cross and three empty 2×2 cm square boxes displayed against a black background. The three boxes were aligned in a horizontal row and the distance between the midpoint of the central box and the midpoints of the left and right boxes was 4 cm. A fixation cross was displayed within the central box at the geometric centre of the screen. An acoustic signal delivered from an acoustic box incorporated in the notebook served as a warning signal. The cue consisted of the brightening of the perimeter of one of the three boxes. The target was a multicoloured 1.5×1.5 cm square pattern shown in the centre of one of the three boxes. A response box connected to the notebook through a parallel port was used to record RTs, while the keyboard of the notebook was used by the examiner to run the experiment.

2.1.3. Procedure

All experimental sessions were conducted in a sound- and light-attenuated room. Participants were seated in front of the computer monitor at a distance of 57 cm, so that 1 cm on the screen subtended 1° of visual angle. On each trial the acoustic warning signal prompted the subject to direct and hold the eye gaze on the fixation cross. After an interval unpredictably ranging from 200 to 300 ms, a cue was displayed for 45 ms. The target was then shown for 50 ms at a CTOA of 150, or 360, or 570 ms (see Fig. 1 for details).

2.1.4. Task

The task required participants to press a response key with the preferred hand on a box in front of them as soon as they saw the target while maintaining fixation. On catch trials only the cue was presented and participants were to withhold key pressing.

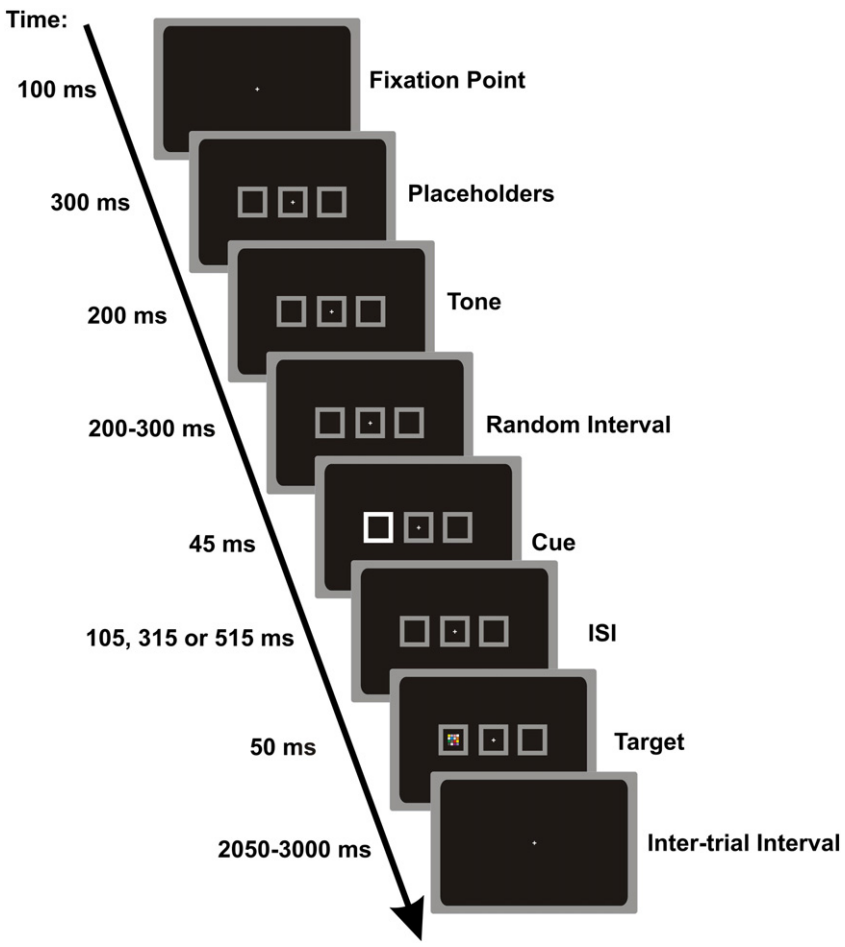

Fig. 1. Schema of the stimuli and procedure for Experiment 1.