Neuroscience Letters 578 (2014) 128–132

Contents lists available at ScienceDirect

Neuroscience Letters

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

The spatial distribution of inhibition of return revisited: No difference found between manual and saccadic responses

Benchi Wang[a,b,c], Matthew D. Hilchey[d], Xiaohua Cao[a], Zhiguo Wang[b,c,*]

[a] Department of Education, Zhejiang Normal University, China
[b] Center for Cognition and Brain Disorders, Hangzhou Normal University, China
[c] Zhejiang Key Laboratory for Research in Assessment of Cognitive Impairments, China
[d] Department of Psychology & Neuroscience, Dalhousie University, Canada

HIGHLIGHTS

- Inhibition of return (IOR) is not restricted to previously attended locations.
- We examine the spatial distribution of IOR with manual and saccadic responses.
- The spatial distribution of IOR cannot be differentiated on the basis of response.
- The spatial distribution of IOR is skewed to more eccentric visual space.

ARTICLE INFO

Article history:
Received 6 April 2014
Received in revised form 20 May 2014
Accepted 13 June 2014
Available online 1 July 2014

Keywords:
Inhibition of return
Saccade
Spatial attention

ABSTRACT

Inhibition of return (IOR) commonly refers to the effect of prolonged response times to targets at previously attended locations. It is a well-documented fact that IOR is not restricted to previously attended locations, but rather has a spatial gradient. Based on a myriad of manual/saccadic dissociations, many researchers now believe that there are at least two forms of IOR completely dissociable on the basis of response type. The present study evaluated whether these two forms of IOR are encoded in similar representations of space. Across a range of conditions, there was little indication that the two forms could be differentiated on the basis of their spatial distributions. Furthermore, the present study also found that the gradient of IOR was steepest for cues appearing nearest fixation.

© 2014 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Response times (RTs) are slowest toward the location of a transient, spatially uninformative visual signal (a cue) when the interval between the cue and response target exceeds about 200 ms (see [1], for a review). This phenomenon was popularized by Posner and Cohen [2–4] in the spatial cueing paradigm [5] and was later named *inhibition of return* (IOR) [6]. In the seminal demonstration, a visual target appearing in peripheral vision and requiring a speeded response was preceded by an abrupt, spatially uninformative visual onset cue. Initially, RTs to targets appearing at the cued location were fastest. This robust finding is usually attributed to the covert orienting of attention toward the cue [5]. This short-lasting facilitatory effect of attentional orienting gives way to enduring IOR (lasting up to 3 s, see [7] for a graphical meta-analysis). Posner and Cohen suggested that IOR might have been evolved to maximize the sampling of visual information [3]. Posner and colleagues later demonstrated that the mechanisms underlying IOR bias responses against previously inspected locations [6]. Experimental work by Klein and colleagues [8–10] extended this functional explanation of IOR to foraging, demonstrating that IOR facilitates visual search by discouraging reinspections in serial search and complex visual search tasks (for a review, see [11]).

IOR is not restricted to the cued location, but rather has a spatial gradient [12–22]. For instance, in Bennett and Pratt [12], an onset cue at the center of one quadrant of the visual field was followed by a simple manual response target, which could appear at one of 441 locations equally distributed in a $21^\circ \times 21^\circ$ region. The slowest target detection response was observed at the cued location and this effect spread beyond the cued location – decreasing as a function of cue-target distance – but nevertheless spreading to the hemi-field opposite the cue. When multiple transient onset cues are

* Corresponding author at: Center for Cognition and Brain Disorders, Hangzhou Normal University, Wenzhou Road 126, Gongshu District, Hangzhou 310015, China.
E-mail address: z.wang@hznu.edu.cn (Z. Wang).

http://dx.doi.org/10.1016/j.neulet.2014.06.050
0304-3940/© 2014 Elsevier Ireland Ltd. All rights reserved.

displayed simultaneously, similar gradients extend outward from the center of gravity – or geometric midpoint – of the cueing arrays [15,18].

Although many investigations (see above) have examined the spatiotemporal dynamics of IOR as a function of cue-target distance, only one investigation [15] has studied whether gradients of IOR are distinguishable on the basis of response type. The paucity of research on this matter is surprising given that experimental work has converged on the notion that the causes and effects of IOR are completely dissociable on the basis of whether the spatial cueing paradigms entail oculomotor and/or keypress responses [23–31], see [32] for a review. Whether IOR is output- (i.e., motoric/decision) or input- (i.e., perception/attention) based depends on whether the oculomotor circuitry responsible for reflexively generated saccades is quiescent or active in the spatial cueing paradigm [25,31–34]. Input-based IOR is generated when the reflexive oculomotor system is quiescent, as in when reflexive saccadic eye movements are expressly forbidden, whereas output-based IOR is generated when the oculomotor system is actively engaged [31,32], as in when reflexive saccadic eye movements are permitted or required to cued locations. In expression, output-based IOR effects are best characterized as speed accuracy tradeoffs whereas input-based IOR effects are best characterized as genuine reductions in performance at the cued location [33,35,36]. The single study (as aforementioned) that has contrasted the spatiotemporal dynamics of input- and output-based forms of IOR as a function of cue-target distance demonstrated striking similarities between them [15]. This observation gives rise to the possibility that both input- and output-based forms of IOR are encoded in the same representation of space. This attribution, however, is made complicated by the high frequency of erroneous saccadic eye movements in the experiment in which manual, not saccadic, responses were required [18]. Indeed, in this experiment, eye movements were made on ~30% of the experimental trials and on ~45% of the "catch" trials on which no response was required. Moreover, observers were not given any explicit feedback in the event of an erroneous oculomotor response. The absence of feedback forbidding oculomotor responding is particularly problematic given that Hilchey et al. have recently demonstrated that IOR is output-based in covert spatial orienting paradigms unless oculomotor responding is expressly discouraged via immediate visual feedback [33]. We worry that the combination of a high rate of oculomotor responding and the absence of explicit feedback warning observers to refrain from reflexively shifting their gaze in Klein, Christie and Morris [18] may have allowed for the output-based form of IOR. Their pattern of results thus may have emerged *not* because input- and output-based forms are encoded in the same representation of space but rather because output-based IOR was probed in both experiments.

In the present investigation, we evaluate spatial gradients of input- and output-based IOR by requiring either manual or saccadic localization responses to visual targets appearing 400 ms after the onset of visual cues. Importantly, immediate visual feedback warning observers to refrain from making saccadic eye movements was delivered at any point time in which an erroneous saccade was detected. In addition to administering variations on the spatial cueing paradigm known to elicit either output- and input-based forms of IOR, our experimental methods were based off of Dorris et al. [17] (see Section 2 for details) and distinct from those in Klein, Christie, and Morris [18] and Christie, Hilchey and Klein [15] in which "center of gravity" effects – the result of multiple simultaneous cues – were of principal interest. We contrast the gradients between input- and output-based forms of IOR under different conditions to ensure that any similarities between them – if observed – are robust across experimental conditions.

2. Method

The research protocol reported here was approved by the Institutional Review Board of Center for Cognition and Brain Disorders at Hangzhou Normal University and all participants gave written informed consent.

2.1. Participants

Eleven graduate students and one faculty member (7 female, 5 male) participated in this experiment in exchange for monetary compensation (40 Yuan/h). They were right-handed, naive to the purpose of the present experiment, and reported normal or corrected-to-normal visual acuity. The mean age was 25.4 (SD = 2.7) years.

2.2. Apparatus and stimuli

Participants were tested in a sound-proof, dimly lit laboratory. Visual stimuli were presented on a 21-inch CRT monitor, controlled by a Windows 7 PC (32-bit), equipped with an Intel Core i5-3470 processor (3.2 GHz). The viewing distance was held constant at about 71 cm by using a chin-rest. Stimulus presentation and response registration were controlled by custom software written in Python. A video-based eye tracker (Eyelink® 1000), with a spatial resolution of 0.2° visual angle or better, was used to monitor the participant's gaze direction at a sampling rate of 500 Hz.

The cue was a white empty square (216.8 cd/m^2) measuring 1° × 1° visual angle and the target was a white filled disk (216.8 cd/m^2) with a diameter of 1° visual angle. All stimuli were presented against a black background (6.08 cd/m^2). The target was always presented on the horizontal meridian, 8° left or right to the center of the display. To evaluate the spatial gradient of input- and output-based forms of IOR, we administered variations on two "stimulus-saccade" conditions (the "direction" and "eccentricity" series) from Dorris, Taylor, Klein and Munoz's investigation [17], except that we (1) made some qualitative changes to the visual stimuli and stimulus presentation procedures (e.g., we removed the gap effect because it is known to interact with output- but not input-based IOR [26]), and (2) added corresponding manual response conditions expressly forbidding oculomotor responding but that were, importantly, otherwise identical to the saccade conditions. In the "direction series", the cue appeared on a virtual circle with a radius of 8° whereas in the "eccentricity series" the cue appeared on the horizontal meridian. The cue-target distances were multiples of 22.5° (polar angle) or 2° (visual angle) for the direction and eccentricity series, respectively. Those two series were randomly intermixed within blocks of trial such that on any given trial the cue could appear at any one of 26 locations (see Fig. 1).

2.3. Procedure and design

Self-paced drift check was performed at the beginning of each trial, then a white fixation cross (1° × 1°) appeared at the center of the display and remained visible for the entire trial. After an interval of 1000 ms, the cue appeared randomly at one of 26 possible locations. Participants were told that the cue was spatially uninformative and that it should be ignored. The cue was displayed for 100 ms and the target appeared 300 ms after cue offset (i.e., the cue target onset asynchrony was 400 ms). To minimize anticipatory responses, targets were not presented on 10% of the trials ("catch" trials). When presented, the target appeared for 1500 ms or until the participant made a response. In the saccadic response condition, participants were instructed to make speeded saccadic responses toward the target. In the manual response condition, participants were instructed to make speeded 'Z' (left hand) or '/' (right hand)

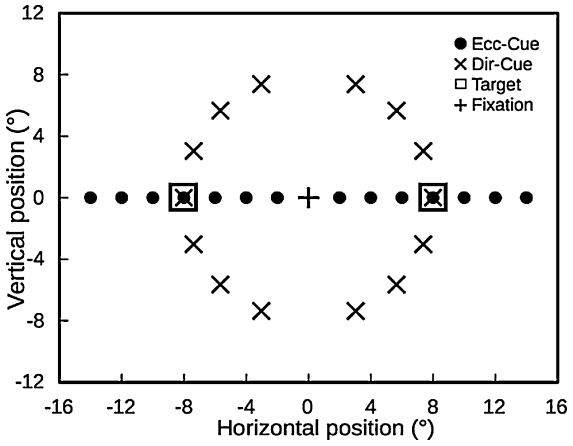


Fig. 1. Possible cue and target locations. Ecc-Cue and Dir-Cue denote cue locations in eccentricity and direction series, respectively.

localization responses on a standard QWERTY keyboard for targets appearing left or right of fixation, respectively. Between each trial, there was a random interval between 750 and 1250 ms.

The manual and saccadic response conditions were tested in two separate sessions, with their order being counterbalanced across participants. Each session comprised four blocks of 130 trials. In the manual response condition, participants were required to maintain fixation at all times; immediate visual warning messages discouraging oculomotor responding was displayed if gaze deviated more than 2° visual angle from fixation. In addition, participants also received warning messages if they pressed the wrong key. In the saccadic response condition, the participant maintained fixation until the appearance of the target at which point they shifted their gaze toward it. Warnings were issued if the participant's gaze shifted more than 2° from fixation before target onset, or if the landing position of the primary saccade missed the target by more than 2°. All trials with warnings were later presented to the participant, until all trials were completed successfully. Participants were made aware of the requirement to successfully complete the trials.

3. Results

For the manual response condition, trials on which the RTs were faster than 200 ms (0.23%) or slower than 1000 ms (0.14%) were excluded from analyses. For the saccadic condition, trials were excluded if the RTs were faster than 100 ms (0.25%) or slower than 600 ms (0.36%). Those trimming criteria were determined based on an eyeball inspection of the RT distributions. Because each experimental cell had only 9 trials, to reduce the effect of outliers, RTs were further trimmed on a per experimental cell, per subject basis. As recommended by Van Selst and Jolicoeur [37], RTs that were 2.12 standard deviations faster or slower than the mean of an experimental cell were also removed (2.88% for manual response condition, 2.58% for saccadic response condition). Those data cleansing procedures excluded a very small amount of trials altogether (3.26% for manual response condition, 3.19% for saccadic response condition). Visual feedback was provided immediately following the detection of pre-target eye movements. This manipulation was effective in discouraging such eye movements. Pre-target eye movements occurred on only 32 and 24 trials for the manual and saccadic response conditions [$t(11) = 1.32$, $p > 0.20$].

Mean RTs for each experimental cell are presented in Fig. 2. Analyses of variance (ANOVAs) on RTs revealed no main effect or interaction involving target location (left vs. right) in both eccentricity series [all $F < 1.42$, all $p > 0.15$] and direction series [all $F < 1.05$, all $p > 0.40$]. Thus, left- and right-target trials were collapsed to increase power in further analyses.

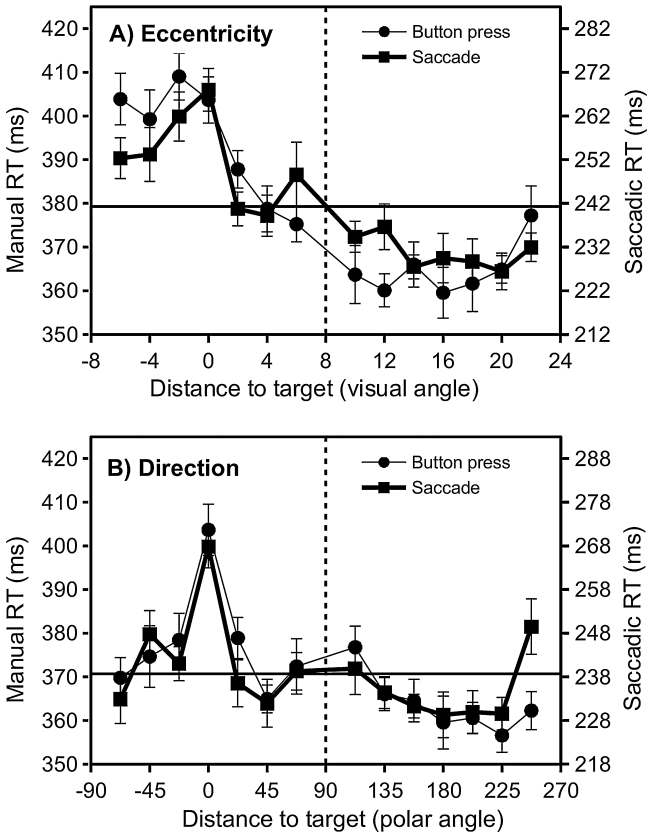


Fig. 2. The spatial distribution of IOR for manual and saccadic responses in the eccentricity (A) and direction (B) series. The dashed lines denote the vertical meridian, whereas the solid horizontal lines mark the mean RTs of both saccadic and manual response conditions. In the eccentricity series (A), negative values on the *x*-axis denote that the cue was presented at more eccentric locations relative to the target in the cued hemifield. In the direction series (B), negative values on the *x*-axis denote that the cue was presented in the upper visual field, on the same side (left or right) as the target. Error bars denote ±1 SEM.

3.1. Eccentricity series

A repeated measures ANOVA on RTs from the eccentricity series, with variables response mode (manual vs. saccadic) and cue-target distance, revealed significant main effects of response mode [$F(1, 11) = 74.42$, $p < 0.001$, partial $\eta^2 = 0.88$] and cue-target distance [$F(13, 143) = 13.67$, $p < 0.001$, partial $\eta^2 = 0.55$]. RTs were generally longer in manual than in saccadic trials. The longest RTs were obtained when the cue appeared at the target location. As cue-target distance increased mean RT was reduced, revealing a gradient of IOR. Critically, the 2-way interaction between response mode and cue-target distance did not reach significance [$F(13,143) = 1.58$, $p = 0.1$, partial $\eta^2 = 0.13$], suggesting that the two forms of IOR are not easily distinguished on the basis of their spatial distributions.

Of secondary interest, and as clearly illustrated in Fig. 2A, as cue-target distance increased, RTs decreased more gradually following cues in far (>8° of visual angle) than near peripheral vision (<8° of visual angle) in the cued hemifield. A similar pattern of results was borne out in the saccadic responding of non-human primates (see Fig. 5B of [17]). To substantiate this asymmetric gradient, we compared between target RTs in the cued hemifield following cues in near and far peripheral vision at distance-matched cue-target eccentricities. For manual responses, mean RTs were statistically

faster following cues in near relative to far peripheral vision at 2°, 4° and 6° cue-target distances [all $t > 2.72$, all $p < 0.02$]. For saccadic responses, significant and marginally significant differences were observed at 2° [$t(11) = 3.07$, $p < 0.05$] and 4° [$t(11) = 1.99$, $p = 0.07$], respectively.

3.2. Direction series

A repeated measures ANOVA on RTs from the direction series, with variables response mode and cue-target distance, revealed significant main effects of response mode [$F(1, 11) = 64.74$, $p < 0.001$, partial $\eta^2 = 0.86$] and cue-target distance [$F(13, 143) = 8.06$, $p < 0.001$, partial $\eta^2 = 0.42$]. As in the eccentricity series, the main effect of response mode was because RTs were generally longer in manual than in saccadic response trials. The main effect of cue-target distance was because, as is clear from Fig. 2B, RTs were longer when the cue appeared at the target location and decreased as the cue-target distance increased, revealing a gradient of IOR. Importantly, consistent with the results of the eccentricity series, the 2-way interaction between response mode and cue-target distance was not significant [$F < 1$, n.s.], again suggesting that a similar gradient of IOR was observed in manual and saccadic response trials.

4. Discussion

It is well-documented that IOR has a spatial gradient [12–15,18–20,22]. Consistent with previous reports, the results of the present investigation reveal that the magnitude of the IOR effect – whether measured by a saccadic or manual response – decreases steadily as a function of cue-target distance. Although myriad investigations have demonstrated that there are at least two fundamentally dissociable forms of IOR on the basis of either response type [26] or the activation state of the oculomotor system responsible for reflexively generated saccades [31,32], the present report makes clear that these two forms of IOR are not easily distinguished by their spatial gradients.

Until now, only one study [15] has contrasted between saccade- and manual-response measured gradients of IOR and, like us, this study reported that input- and output-based forms of IOR were encoded in similar if not the same representations of space. Unfortunately, the comparison recently made by Christie and colleagues was compromised because of the high frequency of oculomotor responses in the manual response condition in the absence of express visual feedback forbidding such responses [18]. Simply, instead of contrasting between input- and output-based forms of IOR, Christie et al. may have contrasted between two output-based forms of IOR.

The present study improves on certain aspects of Christie et al's investigation in several ways. First, Hilchey and colleagues recently demonstrated that actively discouraging erroneous saccadic eye movements in go/no-go tasks alters the form of IOR: when saccadic eye movements are actively discouraged, the form of IOR is input-based; when no saccade response feedback is issued, the form of IOR is output-based [33]. This finding called into question the legitimacy of the Christie et al. interpretation. In the present investigation, we discouraged saccadic responses by providing immediate visual feedback at any point in which an erroneous saccadic response was detected so as to ensure that the form of IOR in the manual response condition was input-based. Nevertheless, some readers may wonder whether stringent feedback in the present investigation conduced to input-based forms of IOR in both the saccade and manual response conditions. We consider this possibility unlikely. Previous investigations actively discouraging erroneous saccadic responses (e.g., to the cue) in spatial cueing paradigms requiring oculomotor responses have robustly observed output-based effects. So long as anti-saccade responses are not required [38], pro-saccadic responses generate output-based effects whether visual [31] or auditory [25] feedback is provided, or if the trial is spontaneously aborted upon the detection of an erroneous saccadic eye movement [39]. Second, whereas Christie et al. opted for simple keypress detection responses in their manual response condition, we opted for manual localization responses. The lynchpin investigation [31] revealing difference between the forms of IOR depending on whether saccadic responses were required or prohibited also required manual localization responses. More practically, however, a manual localization response is a better proxy for saccades, which are localization responses by nature. Third, we deliberately departed from Christie et al's methods and instead instantiated modified versions of Dorris et al's "eccentricity" and "direction" series. Despite substantial differences between methods in the present investigation and those in Christie et al., there were nevertheless no statistically distinguishable differences between the two forms of IOR in either experiment.

5. Conclusion

Replicating and extending previous findings [15], the present investigation revealed that it is difficult if not impossible to distinguish between the two forms of IOR on the basis of their spatial gradients. This finding implies that the two forms of IOR are encoded in similar representations of space. Of secondary interest, as the cue-target distance increased in the eccentricity series, the gradient of IOR was steepest when cues appeared nearest fixation in the cued hemifield. This finding may indicate that the spatial properties of IOR are better accounted for in cortical rather than absolute environmental space.

Acknowledgement

This project was supported by a grant (Grant #: 31371133) from the National Natural Science Foundation of China to Z. Wang.

References

[1] R. Klein, Inhibition of return, Trends Cogn. Sci. 4 (13) (2000) 8–147, http://dx.doi.org/10.1016/S1364-6613(00)01452-2.
[2] M.I. Posner, Y. Cohen, R.D. Rafal, Neural systems control of spatial orienting, Philos. Trans. R. Soc. Lond. B: Biol. Sci. 298 (1982) 187–198.
[3] M.I. Posner, Y. Cohen, Components of visual orienting, in: H. Bouma, D.G. Bouwhuis (Eds.), Attention and Performance X: Control of Language Processes, Erlbaum, Hillsdale, NJ, 1984, pp. 531–556.
[4] Y. Cohen, Internal and External Control of Orienting (Doctoral dissertation), University of Oregon, 1981.
[5] M.I. Posner, C.R. Snyder, B.J. Davidson, Attention and the detection of signals, J. Exp. Psychol. 109 (1980) 160–174.
[6] M.I. Posner, R.D. Rafal, L.S. Choate, J. Vaughan, Inhibition of return: neural basis and function, Cogn. Neuropsychol. 2 (1985) 211–228, http://dx.doi.org/10.1080/02643298508252866.
[7] A. Samuel, D. Kat, Inhibition of return: a graphical meta-analysis of its time course and an empirical test of its temporal and spatial properties, Psychon. Bull. Rev. 10 (2003) 897–906.
[8] R.M. Klein, J.W. Macinnes, Inhibition of return is a foraging facilitator in visual search, Psychol. Sci. 10 (1999) 346–352, http://dx.doi.org/10.1111/1467-9280.00166.
[9] R. Klein, Inhibitory tagging system facilitates visual search, Nature 334 (1988) 430–431, http://dx.doi.org/10.1038/334430a0.
[10] W.J. MacInnes, A.R. Hunt, M.D. Hilchey, R.M. Klein, Driving forces in free visual search: an ethology, Atten. Percept. Psychophys. 76 (2014) 280–295, http://dx.doi.org/10.3758/s13414-013-0608-9.
[11] Z. Wang, R.M. Klein, Searching for inhibition of return in visual search: a review, Vis. Res. 50 (2010) 220–228, http://dx.doi.org/10.1016/j.visres.2009.11.013.
[12] P. Bennett, J. Pratt, The spatial distribution of inhibition of return, Psychol. Sci. 12 (2001) 76–80, http://dx.doi.org/10.1111/1467-9280.00313.
[13] G. Berlucchi, G. Tassinari, C.A. Marzi, M. Di Stefano, Spatial distribution of the inhibitory effect of peripheral non-informative cues on simple reaction time to non-fixated visual targets, Neuropsychologia 27 (1989) 201–221.

[14] E. Birmingham, T. Visser, J. Snyder, A. Kingstone, Inhibition of return: unraveling a paradox, Psychon. Bull. Rev. 14 (2007) 957–963.
[15] J. Christie, M.D. Hilchey, R.M. Klein, Inhibition of return is at the midpoint of simultaneous cues, Atten. Percept. Psychophys. 75 (2013) 1610–1618, http://dx.doi.org/10.3758/s13414-013-0510-5.
[16] A. Collie, P. Maruff, M. Yucel, J. Danckert, J. Currie, Spatiotemporal distribution of facilitation and inhibition of return arising from the reflexive orienting of covert attention, J. Exp. Psychol. Hum. Percept. Perform. 26 (2000) 1733–1745.
[17] M.C. Dorris, T.L. Taylor, R.M. Klein, D.P. Munoz, Influence of previous visual stimulus or saccade on saccadic reaction times in monkey, J. Neurophysiol. 81 (1999) 2429–2436.
[18] R.M. Klein, J. Christie, E.P. Morris, Vector averaging of inhibition of return, Psychon. Bull. Rev. 12 (2005) 295–300.
[19] L.K. Langley, N.D. Gayzur, A.L. Saville, S.L. Morlock, A.G. Bagne, Spatial distribution of attentional inhibition is not altered in healthy aging, Atten. Percept. Psychophys. 73 (2011) 766–783, http://dx.doi.org/10.3758/s13414-010-0059-5.
[20] E.A. Maylor, R. Hockey, Inhibitory component of externally controlled covert orienting in visual space, J. Exp. Psychol. Hum. Percept. Perform. 11 (1985) 777–787.
[21] J. Vaughan, Saccades directed at previously attended locations in space, in: A.G. Gale, F. Johnson (Eds.), Theoretical and Applied Aspects of Eye Movement Research, Elsevier Science, North-Holland, 1984, pp. 143–150.
[22] Z. Wang, J. Theeuwes, Dissociable spatial and temporal effects of inhibition of return, PLoS ONE 7 (2012) e44290, http://dx.doi.org/10.1371/journal.pone.0044290.
[23] A. Bourgeois, A.B. Chica, R. Migliaccio, M. Thiebaut de Schotten, P. Bartolomeo, Cortical control of inhibition of return: evidence from patients with inferior parietal damage and visual neglect, Neuropsychologia 50 (2012) 800–809, http://dx.doi.org/10.1016/j.neuropsychologia.2012.01.014.
[24] A. Bourgeois, A.B. Chica, A. Valero-Cabré, P. Bartolomeo, Cortical control of inhibition of return: causal evidence for task-dependent modulations by dorsal and ventral parietal regions, Cortex 49 (2013) 2229–2238, http://dx.doi.org/10.1016/j.cortex.2012.10.017.
[25] A. Chica, T. Taylor, J. Lupiáñez, R. Klein, Two mechanisms underlying inhibition of return, Exp. Brain Res. 201 (2010) 25–35, http://dx.doi.org/10.1007/s00221-009-2004-1.
[26] A.R. Hunt, A. Kingstone, Inhibition of return: dissociating attentional and oculomotor components, J. Exp. Psychol. Hum. Percept. Perform. 29 (2003) 1068–1074.
[27] A. Kingstone, J. Pratt, Inhibition of return is composed of attentional and oculomotor processes, Percept. Psychophys. 61 (1999) 1046–1054.
[28] J. Lupianez, R. Klein, P. Bartolomeo, Inhibition of return: twenty years after, Cogn. Neuropsychol. 23 (2006) 1003–1014.
[29] D.T. Smith, T. Schenk, C. Rorden, Saccade preparation is required for exogenous attention but not endogenous attention or IOR, J. Exp. Psychol. Hum. Percept. Perform. 38 (2012) 1438–1447, http://dx.doi.org/10.1037/a0027794.
[30] P. Sumner, P. Nachev, N. Vora, M. Husain, C. Kennard, Distinct cortical and collicular mechanisms of inhibition of return revealed with S cone stimuli, Curr. Biol. 14 (2004) 2259–2263, http://dx.doi.org/10.1016/j.cub.2004.12.021.
[31] T.L. Taylor, R.M. Klein, Visual and motor effects in inhibition of return, J. Exp. Psychol. Hum. Percept. Perform. 26 (2000) 1639–1656.
[32] R.M. Klein, M. Hilchey, Oculomotor inhibition of return, in: S. Liversedge, I. Gilchrist, S. Everling (Eds.), Oxford Handbook of Eye Movement, Oxford University Press, London, UK, 2011, pp. 471–492.
[33] M.D. Hilchey, M. Hashish, G.H. Maclean, J. Satel, J. Ivanoff, R.M. Klein, On the role of eye movement monitoring and discouragement on inhibition of return in a go/no-go task, Vis. Res. 96 (2014) 133–139, http://dx.doi.org/10.1016/j.visres.2013.11.008.
[34] J. Satel, M.D. Hilchey, Z. Wang, R. Story, R.M. Klein, The effects of ignored versus foveated cues upon inhibition of return: an event-related potential study, Atten. Percept. Psychophys. 75 (2013) 29–40, http://dx.doi.org/10.3758/s13414-012-0381-1.
[35] A.B. Chica, J. Lupiáñez, Effects of endogenous and exogenous attention on visual processing: an inhibition of return study, Brain Res. 1278 (2009) 75–85, http://dx.doi.org/10.1016/j.brainres.2009.04.011.
[36] J. Ivanoff, R. Klein, J. Lupianez, Inhibition of return interacts with the Simon effect: an omnibus analysis and its implications, Percept. Psychophys. 64 (2002) 318–327.
[37] M. Van Selst, P. Jolicoeur, A solution to the effect of sample size on outlier elimination, Q. J. Exp. Psychol. Sect. Hum. Exp. Psychol. 47 (1994) 631–650, http://dx.doi.org/10.1080/14640749408401131.
[38] J.H. Fecteau, C. Au, I.T. Armstrong, D.P. Munoz, Sensory biases produce alternation advantage found in sequential saccadic eye movement tasks, Exp. Brain Res. 159 (2004) 84–91, http://dx.doi.org/10.1007/s00221-004-1935-9.
[39] M.D. Hilchey, R.M. Klein, J. Ivanoff, Perceptual and motor inhibition of return: components or flavors? Atten. Percept. Psychophys. (2012), http://dx.doi.org/10.3758/s13414-012-0332-x.