Can the exploration of left space be induced implicitly in unilateral neglect?

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Abstract

The purpose of the present study was to explore the ability of neglect patients to detect and exploit the predictive value of a cue to respond more quickly and accurately to targets on their contralesional side in a Posner spatial cueing task. The majority of the cues (i.e. 80%) were invalid, indicating that the target would appear on the opposite side, although patients were not informed of this bias. Our results demonstrate that some neglect patients were able to extract the cue's predictability and use it to orient faster toward the left. This cueing effect was present even in patients who were subsequently unable to describe the predictive character of the cues, and thus was not modulated by reportable awareness of the cue-target relation.

Keywords: Spatial attention, implicit orienting, visual neglect, consciousness

1. Introduction

Left visual neglect is a common disorder resulting from unilateral hemispheric damage, often as a consequence of resulting dysfunction in fronto-parietal networks in the right hemisphere (Bartolomeo, Thiebaut de Schotten, & Doricchi, 2007), which include networks that are important for the spatial orienting of attention (Bartolomeo, Zieren, Vohn, Dubois, & Sturm, 2008; Corbetta & Shulman, 2002). Neglect patients tend to explore mainly ipsilesional locations, and are unable to orient, report, or respond to events contralateral to the side of the brain lesion (Heilman, Watson, & Valenstein, 2011). Typically associated with patients' unawareness of their difficulties (anosognosia), neglect is often difficult to rehabilitate (Bartolomeo, 2014). Although different impairments may contribute to the syndrome, attentional disorders play a prominent role in visual neglect, including disorders of impaired spatial orienting, which is heavily rightward-biased (for a review, see Bartolomeo, Thiebaut de Schotten, & Chica, 2012).

The orienting of attention does not rely on a unitary system. Spatial attention can be oriented either endogenously (i.e., in a voluntary or top-down fashion) or exogenously (i.e., in an automatic or bottom-up fashion; Chica, Bartolomeo, & Lupianez, 2013; Chica, Bartolomeo, & Valero-Cabre, 2011; James, 1890; Posner, 1980). The Posner spatial cueing task has been widely used to study the spatial orienting of attention in healthy participants (e.g. Chica, Bartolomeo, et al., 2011; Chica, Lasaponara, et al., 2011; Lopez-Ramon, Chica, Bartolomeo, & Lupianez, 2011; Ruz & Lupianez, 2002) as well as in brain-damaged patients (e.g. Bartolomeo, Decaix, Siéroff, & Chokron, 2001; Bartolomeo et al., 2012; Chica et al., 2012; Losier & Klein, 2001; Natale, Posteraro, Prior, & Marzi, 2005; Posner, Walker, Friedrich, & Rafal, 1984). In one version of this paradigm, targets are preceded by peripheral cues (e.g., a brief brightening) at various stimulus onset asynchronies (SOAs). The cues are either valid or invalid: i.e., they indicate either the target's location or the opposite location. Spatially non-predictive cues — i.e. targets that appear with equal proportion in the cued or in the uncued locations — are used to orient attention exogenously or automatically (Muller & Rabbitt, 1989). In this condition, a validity effect is usually observed, with lower response times (RTs) for valid cue-target trials as compared to invalid trials at short SOAs (< 300 ms). The reverse pattern appears at SOAs longer than 300 ms, with faster RTs on invalid than on valid trials, a phenomenon known as inhibition of return (IOR: see Klein, 2000; Lupianez, Klein, & Bartolomeo, 2006 for details).

As the predictive value of the cue is increased, the initial exogenous bottom-up orienting mechanisms are replaced by an endogenous, top-down, shift of attention. This endogenous orienting is generally described as involving controlled attentional mechanisms: according to this view, it is awareness of the cue's spatial utility (i.e., the degree to which the cue location predicts the target location) that enables subjects to strategically allocate attention in response to the cue (Bartolomeo & Chokron, 2002; Santangelo & Spence, 2008). In this situation, the cueing effect increases considerably and persists at longer SOAs, to an extent that depends on the proportion of valid trials (Bartolomeo, Decaix, & Sieroff, 2007; Risko & Stolz, 2010).

To investigate attentional orienting in visual neglect, Bartolomeo et al. (2001) used peripheral cues with different degrees of predictive value (20%, 50%, and 80% of cued trials). Participants were informed of the predictive value of the cue before each session and encouraged to use it to respond as quickly and precisely as possible. The results showed that exogenous orienting was particularly impaired in visual neglect: there was no evidence of IOR for right targets and a disproportionate cost when left targets were preceded by invalid right cues (Losier & Klein, 2001; Posner et al., 1984). Nevertheless, endogenous orienting seemed to be relatively spared, albeit slowed, in neglect patients. When the cues predicted the appearance of the target at the opposite location in 80% of trials, neglect patients were able to respond as quickly for the left as for the right targets. However, this happened only at the longest SOA (1000 ms), whereas age-matched controls were already able to take advantage of the information provided by the cues at an SOA of 550 ms. The apparent ability of the neglect patients in this study to take advantage of the predictive value of the cue to respond more accurately and quickly to left targets has been interpreted to suggest preservation of endogenous controlled processes (see also Ladavas, Carletti, & Gori, 1994; Smania et al., 1998). Interestingly, although Bartolomeo et al.'s (2001) participants were informed of the cue's predictability, in the informal debriefing following reaction time task some claimed not to have paid attention to the cues at all, but simply to have tried to respond to the targets as quickly as possible. The conclusion that these cueing effects were the result of motivated strategic considerations or expectancies could thus be challenged.

In fact, some authors have questioned the purely explicit and "controlled" nature of endogenous attentional orienting (Bartolomeo, Decaix, et al., 2007; Lambert, 2003; Lambert, Naikar, McLachlan, & Aitken, 1999; Lopez-Ramon et al., 2011; Risko & Stolz, 2010). To better understand the phenomenology of endogenous orienting in healthy subjects, Bartolomeo et al. (2007) used a Posner procedure but manipulated the information given to the participants before the testing session: half were informed of the cue-target relation, and the other half were not. They observed that participants from the non-informed group benefited as much from the cues to orient quickly towards the targets as the participants in the informed group—regardless of their ability to verbally report the cue-target relation. These results suggested that the subjects' sensitivity to the probabilistic association between the cue and the target in the Posner paradigm might be sustained by more implicit mechanisms that can function in the absence of awareness of the cue-target relation (see also Bartolomeo et al. 2008; Chica & Bartolomeo, 2010; Lopez-Ramon et al., 2011). Lambert et al. (1999) distinguished this component of visual orienting as the *implicit peripheral cueing effect*. This implicit process is separate from both reflexive (i.e., bottom-up) and voluntary (i.e., top-down) orienting, and can guide visual attention depending on spatial regularities (Lambert, Norris, Naikar, & Aitken, 2000).

In daily life, neglect patients seem to be unable to consciously use their preserved endogenous abilities to compensate for their attentional difficulties, i.e., to orient their attention toward the contralesional side in a controlled way. On the other hand, it has been shown that right brain-damaged patients with and without neglect can be sensitive to environmental regularities, as shown by their statistical learning abilities for target positions in visual search (spatial repetition: Saevarsson, Joelsdottir, Hjaltason, & Kristjansson, 2008), and also in spatial priming, albeit to a lesser extent (Shaqiri & Anderson, 2012, 2013).

If implicit learning abilities are preserved in neglect patients, and if their ability to detect the predictive value of cues presented in RT tasks (cueing paradigm) is based on their implicit sensitivity to environmental regularities, then a further question of interest is whether these implicit attentional processes could be used to help patients detect and respond to stimuli presented to their neglect side. The main purpose of the present study was thus to determine whether neglect patients are able to use the predictive value of the cue to respond more quickly and accurately to targets, without being informed in advance of the cue-target relationship. More particularly, we explored neglect patients' ability to inhibit ipsilesional capture and reorient their attention toward contralesional targets. To this end, we used a cueing paradigm (Posner et al., 1984) in which the majority of the cues (80%) were invalid, indicating that the target would appear on the opposite side.

2. Material and Method

2.1. Participants

Sixteen patients with signs of left visual neglect were recruited from hospitals in France (Paris) and in the French-speaking part of Belgium. Unilateral neglect was diagnosed by the presence of at least two impaired scores on the *Batterie d'Evaluation de la Négligence* (Azouvi et al., 2002). Exclusion criteria were a bilateral lesion, a premorbid history of major psychiatric or neurological diseases, and the presence of hemianopsia. Four patients were excluded because of their inability to perform the task (vigilance). For the 12 remaining patients who were included in the study, the mean time interval between stroke onset and experimental testing was five months (range: 1-8.5 months). Neglect patients were aged from 44 to 77 years (mean age = 60.83, SD = 11.13), and had 8 to 17 years of education (mean = 11.25, SD = 2.63). Twenty-four healthy controls matched with the neglect patients for age (mean age = 54.46, SD = 14.51) and educational level (mean = 12.71, SD = 3.24) constituted the control group. These control subjects did not differ from the neglect group in terms of age, $t(34) = -1.33$, $p = .19$, or educational level, $t(34) = 1.35$, $p = .18$. The study was carried out following the guidelines of the University of Liège ethics review board. All participants gave their written informed consent prior to their inclusion in the study. Table 1 shows demographic and clinical data for the neglect patients.

== INSERT TABLE 1 HERE ==

2.2. Apparatus and stimuli

The E-prime software (Version 2.0) was used to control stimulus presentation and response collection. Two empty black horizontal boxes, 30 mm in width, 15 mm in height, and 1.5-mm thick outline, were displayed on a silver background. The fixation point — a black plus sign — was presented at the center of the screen. The cue consisted of a 300-ms thickening of the contour of one of the boxes. The target was an asterisk (4 mm in diameter) that appeared inside one of the lateral boxes.

2.3. Procedure

The methodology was similar to that of Bartolomeo et al. (2007). All participants were seated comfortably at approximately 50 cm from the computer screen. Care was taken to align the vertical midline of the screen with the body midline. Each trial began with the appearance of the two peripheral boxes and the fixation point for 500 ms. The cue was then displayed for 300 ms. The target appeared at variable SOAs (600, 800, or 1000 ms) from the cue onset, and remained visible for 4 seconds to minimize the possibility of omissions. In each of these blocks, targets and cues appeared with equal probability on the left and right sides. Variable SOAs were used to prevent temporal prediction of target onset. Participants were instructed to maintain fixation on the central cross and respond to the target as quickly and precisely as possible, by pressing the center of the space bar with their right index finger. Eye movements were visually controlled by the experimenter. After an intertrial interval of 1000 ms, a new trial began. Participants were told that the targets would be preceded by cues appearing either around the box in which the target would appear, or around the opposite box, but they were asked to respond exclusively to the targets.

Two blocks of trials were presented without interruption. In the first block[1], consisting of 24 trials preceded by 12 practice trials, valid and invalid cues were presented in equal proportion, rendering these cues uninformative. In the second block, made up of 150 trials interspersed with 12 catch trials, 80% of the cues were invalid (i.e., they were followed by a target appearing on the other side) and 20% were valid. Participants were not informed of the cue-target relationship. After the experiment, they filled out a questionnaire asking them whether (1) they noticed anything special about the experiment, (2) there was any relationship between cue and target, and (3) whether the cue location predicted the target location (on the same side or on the other side). Participants were classified as "verbalizers" if they answered "yes" to the second question and responded correctly to the third question, and as "non-verbalizers" if their response to question 2 was "no" or if they responded incorrectly to the second question. As a further step, we asked participants to give their confidence rating ("pure guess," "probably correct," or "certainly

[1] This uninformative block was always presented first in order to ensure that participants would not detect the cue-target relationship too easily. However, the number of trials in the first block was kept to a minimum in order to avoid disturbing the participants' inferences about the cue-target relationships in the second block.

correct”) to assess their subjective state of consciousness (Wierzchon, Asanowicz, Paulewicz, & Cleeremans, 2012).

3. Results

3.1. RT data

The first 12 trials of Block 1 and the first 18 trials of Block 2 were discarded as practice. Trials with response times outside the range of 150-2000ms were discarded from analyses. This resulted in the exclusion of 1% of responses for controls. A subgroup of patients with severe neglect (*n* = 6) presented a high rate of omissions (35%), which made analysis of their RTs impossible. The remaining patients (*n* = 6) omitted to respond or gave an anticipated response on 2% of trials. For each group of participants (controls and neglect patients), median RTs were entered into a repeated-measures analysis of variance (ANOVA) with verbalization (verbalizers vs. non-verbalizers) as a between-participants factor, and block (Block 1 vs. Block 2), validity (valid vs. invalid), side (left vs. right), and SOA (600, 800, 1000 ms) as within-participant factors. Because right-brain damaged patients and age-matched controls typically have different variances, results from the two groups of participants were analyzed separately (Bartolomeo, Siéroff, Chokron, & Decaix, 2001). On the post-experiment questionnaire, five control participants and four neglect patients (three of them belonging to the moderate group) correctly responded that there was a relationship between cue and target location, and were thus classified as verbalizers. **Controls**

There was no effect of verbalization on the RT task, $F(1,22) = 2.50$, $p = .13$, $\eta^2_p = .10$, nor did this factor interact with other factors (all *p*s > .18). The analysis showed a significant main effect of cue validity, $F(1,22) = 18.37$, $p < .001$, $\eta^2_p = .45$, with faster RTs on invalid trials than on valid trials. There was a significant interaction between block and validity, $F(1,22) = 7.37$, $p = .01$, $\eta^2_p = .25$. Planned comparisons showed a significant difference between valid (mean = 426 ms) and invalid (mean = 383 ms) trials in the informative block (Block 2: $p < .001$), and a significant decrease in RTs on invalid trials between Block 1 (mean = 406 ms) and Block 2 (mean = 383 ms) ($p = .02$) (see Figure 1). The interaction between block and SOA was also significant, $F(2,44) = 3.34$, $p = .04$, $\eta^2_p = .13$, indicating that RTs were faster in Block 2 for the two long SOAs (mean = 402 and 398 ms, respectively) than for the short one (mean = 414 ms).

== INSERT FIGURE 1 HERE ==

Neglect patients

Given the high rate of omissions by the patients with the most severe neglect, we divided the patients' group into two subgroups according to the severity of neglect (moderate vs. severe; see Table 1). An ANOVA on RTs was performed for the moderate group (n = 6), while the analysis was conducted on the percentage of omissions for the severe group (n = 6), as it was not possible to carry out an ANOVA on the RTs of this group.

The RT analysis for the moderate neglect group revealed a significant main effect of side, $F(1,4) = 11.74$, $p = .02$, $\eta^2_p = .75$, with RTs slower for stimuli on the left side (mean = 698 ms) than for those on the right (mean = 553 ms). Importantly, there was an interaction between block and validity, $F(1,4) = 7.73$, $p = .04$, $\eta^2_p = .66$. Planned comparisons showed that the difference between valid and invalid trials was significant only in the informative block (Block 2; $p = .05$). Otherwise, this interaction was not modulated by side or verbalization[2] (ps > .78). Inspection of Figure 2 reveals that endogenous cues in Block 2 shortened RTs to left-sided targets, thereby decreasing the influence of left neglect on responses to the contralesional stimuli. Importantly, this was true for both verbalizing and non-verbalizing patients. No other effect or interaction reached significance.

== INSERT FIGURE 2 HERE ==

In the severe group, only the main effect of side reached statistical significance, $F(1,5)= 11.13$, $p = .02$, $\eta^2_p = .69$, reflecting the fact that these patients made more omissions on the left side (28%) than on the right (4%; Figure 3).

== INSERT FIGURE 3 HERE ==

3.2. Level of consciousness

Based on their response to the last question of the post-questionnaire, we assigned each participant a consciousness score which took into account both the correctness of the answer and the participant's confidence rating (see below). Participants who were given a score above 4 —and who thus (1) correctly reported the cue-target link and (2) demonstrated a relatively high level of confidence— were classified as "conscious" (C), whereas those who scored below 4, having wrongly predicted the cue-target link, were classified as "unconscious" (U). Note that one of the neglect patients, who scored a 4, nevertheless reported that he had selected the correct response by "pure guessing." This participant was excluded from analyses, since it was not possible to determine whether his response was correct by chance (no awareness) or whether he was actually conscious of the cue-target link but not very confident.

	Guess	Probable	Certain
Correct response	4	5 (C)	6 (C)
Wrong response	3 (U)	2 (U)	1 (U)

In order to determine whether the cueing effect (i.e., the difference between valid and invalid RTs in Block 2) depended on the consciousness of the cue-target relation, we performed separate t tests for control and neglect groups with consciousness (conscious vs. unconscious) as a between-participants

[2] To ensure that this classification did not influence our results for neglect patients, we performed a new analysis without including the verbalization variable. The results are substantially similar.

factor, and cueing effect as a within-participant factor. This analysis showed that, in the control group, the cueing effect did not differ according to consciousness status, $t(22) = .64$, $p = .53$. Similar results were obtained for the patient group: consciousness of the cue-target relation did not influence the cueing effect, $t(9) = -1.24$, $p = .25$. This indicates that the cueing effect was similar regardless of the level of consciousness in both the control and neglect groups.

4. Discussion

Despite the fact that endogenous orienting processes are preserved in neglect patients, they seem to be unable to deliberately use these abilities in daily life to compensate for their attentional difficulties. Although endogenous orienting is often viewed as a controlled process based on the strategic allocation of attention, some studies have challenged this conception, demonstrating that endogenous orienting processes can sometimes be independent of consciousness or verbal report (Bartolomeo, Decaix, et al., 2007; Lambert, 2003; Lambert et al., 1999; Risko & Stolz, 2010). The possibility that implicit orienting processes might be preserved in neglect patients, and that these processes could be used to help patients respond to stimuli presented to their contralesional side, has not previously been studied. The purpose of the present study was to investigate neglect patients' ability to use the predictive value of cues to speed the orienting of their attention, without advance information on the cue-target relation (80% invalid trials). More particularly, we explored neglect patients' ability to inhibit ipsilesional capture and reorient their attention toward contralesional targets on the basis of their detection of the cue-target relation. We also tried to determine whether this cueing effect could be observed without any explicit knowledge of the cue-target relation.

Our results showed that, when the cue was informative, healthy participants were able to orient their attention more quickly in the direction opposite the cue. An advantage of 43 ms was observed for invalid trials compared to valid ones in the informative Block 2, whereas RTs for valid (mean = 634 ms) and invalid (mean = 643 ms) trials did not differ in the non-informative Block 1. This result supports the conclusion of Bartolomeo, Decaix, et al. (2007), that in normal participants the effects of cue predictiveness do not depend on the capacity to explicitly detect and report the cue-target relation.

Results in neglect patients were more mixed, and depended on the severity of neglect. All patients showed the expected effect of side, with slower RTs or higher numbers of omissions on the left than the right. In Block 2, only the moderate neglect group was able to take advantage of the cues to speed up their RTs: in this group, an advantage of 103 ms was observed on invalid trials compared to valid ones. Focusing on responses to targets presented on the left side, we observed a decrease in RTs on invalid trials between the two blocks (175 ms for verbalizers and 86 ms for non-verbalizers: see Fig. 2). However, it appears that while this ability to extract the value of the cue improves overall performance, that improvement is not enough to overcome the spatial bias toward the ipsilesional side. This finding suggests that the predominant exogenous deficit in spatial neglect cannot be fully compensated by preserved endogenous processes (Bartolomeo et al., 2001; Natale et al., 2005, Siéroff et al., 2007). Importantly, the patient's consciousness of the cue-target relation does not appear to have influenced RT performance.

In the severe neglect group, we did not observe an increased detection rate for invalid trials in Block 2. These patients seemed to be unable to exploit the statistical relationship between cues and targets to inhibit their spatial bias, regardless of whether they were able to verbally report the cue-target relation. The time elapsed since the lesion (5.4 and 5.8 months, for moderate and severe neglect group respectively) cannot explain the observed difference between the two subgroups of patients. It seems that the severity of visual neglect itself could be the factor that accounts for the difference in cueing effects. However, further studies confirming these results in a larger group of neglect patients will be needed.

Some authors emphasize the importance of the possibility of mutual interference between the different modes of orienting (e.g., Berger, Henik, & Rafal, 2005; Santangelo & Spence, 2008). In keeping with this view, the implicit orienting process in the severe neglect group could have been insufficient to completely inhibit the exogenous orienting effect of the abrupt onset of the peripheral cue, thus resulting in a disengagement deficit, which is a characteristic of visual neglect (Losier & Klein, 2001; Rastelli, Funes, Lupianez, Duret, & Bartolomeo, 2008; Siéroff, Decaix, Chokron, & Bartolomeo, 2007). In addition, Siéroff et al. (2007) demonstrated that some neglect patients presented impairment in endogenous engagement, in addition to their exogenous orienting deficit. The patients with impaired endogenous processes also presented more severe signs of left neglect. Accordingly, in our study, the absence of benefits in patients with severe neglect may be explained by the combination of multiple impairments (i.e., endogenous and exogenous orienting) which made the cue-target relationship impossible to extract.

On the other hand, it is widely recognized that endogenous orienting is a slower process than exogenous orienting (Jonides, 1981). If implicit orienting is also slower to implement, a longer learning time could be required to observe the same facilitation in patients with severe spatial neglect. In our study, the informative block included 138 trials, including 80% invalid cues. While this was sufficient for patients with moderate neglect, further research should investigate the extent to which patients with severe neglect are able to detect and use the cue-target relation when they are given more time to do so.

Furthermore, the observation that some neglect patients were able to use cues presented on the right side to orient their attention toward the left side is important from the perspective of neglect rehabilitation. Spatial neglect syndrome is often associated with a lack of awareness of difficulties (anosognosia), making it particularly difficult to rehabilitate (Beschin, Cocchini, Allen, & Della Sala, 2012). Some techniques, such as prism adaptation (Redding & Wallace, 2006) or optokinetic stimulation (Kerkhoff et al., 2012), involving bottom-up processes, have been found to allow temporary improvement of neglect symptoms (see Bartolomeo, 2014, for a review). Similar benefits have been suggested in statistical learning and spatial priming studies (for a review, see Shaqiri, Anderson, & Danckert, 2013). More specifically, the results of recent studies suggest that neglect patients may benefit from statistical regularities and be able to improve their performance toward the neglected side if they are exposed to regularities in the target position for a long period of time (e.g., three days; see Shaqiri & Anderson, 2012). Similarly, Lucas et al. (2013) showed that the reward value of targets (differential assignment of points on the two sides) can promote attentional orienting toward the neglected side, and, importantly, that this benefit can also occur in the absence of any explicit awareness of the reward contingencies. Together, these observations suggest that use of implicit top-down processes may help patients improve their exploration of the left side. However, determining the impact of these new learning procedures in the rehabilitation of neglect will require further investigation.In line with these previous studies, we have shown that "implicit" learning of the cue-target relation can help some neglect patients to orient faster and more accurately toward neglected space. However, these conclusions must be taken with caution, considering the small number of patients included in this study and the nature of the task that was used. In particular, our task cannot be used to strongly establish purely "implicit" detection and learning of the cue-target relation. In our RT task, the association between the cue and the target was relatively simple: if the cue appears on the right, the target is most likely to appear on the left, and vice versa. The involvement of explicit processes thus cannot be completely excluded, even in the absence of verbal report. The absence of verbal report does not necessarily imply that the cueing effect observed in our study was unconscious: participants may not have acquired sufficient knowledge to verbally report the cue-target relation on the post-questionnaire (Perruchet & Vinter, 2002; Shanks, 2003). Conversely, the presence of verbal report does not mean that participants adopted an explicit strategy to orient their attention in the RT task (Newell, Lagnado, & Shanks, 2007). In order to better control for the involvement of explicit processes, it would be interesting to test neglect patients' ability to detect more complex conditional associations between stimuli using tasks similar to those used in implicit learning studies. Future studies using more complex learning paradigms (e.g., involving the learning of second-order conditional associations) should be carried out to confirm our results.

In conclusion, the results of this study suggest that neglect patients can use information provided by peripheral cues in order to speed their orienting toward neglected space, without necessarily being aware of that information, or at the very least without being able to verbalize their knowledge of it. However, moderate neglect patients' preserved ability to use the value of the cue was not sufficient to fully overcome the spatial bias due to the impairment of exogenous orienting. It also appears that these cueing effects may vary according to the severity of spatial neglect. Verbal report and subjective state of consciousness do not appear to influence the cueing effect. Future studies will be necessary to better understand the ability of neglect patients to implicitly orient their attention toward neglected space, particularly in severe visual neglect, and to determine to what extent this ability is transferable to their daily life.

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Figure Captions

Figure 1

Response times (in ms) for controls by group (verbalizer vs. non-verbalizer) and block (Block 1: 50% valid cues; Block 2: 20% valid cues).

Figure 2

Response times (in ms) for moderate neglect patients by group (verbalizer vs. non-verbalizer), side and block (Block 1: 50% valid cues; Block 2: 20% valid cues).

Figure 3

Response rate for severe neglect patients by side and block (Block 1: 50% valid cues; Block 2: 20% valid cues).