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Attentional impairments following right hemisphere damage with and without hemispatial neglect: A comparative study

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ABSTRACT
This study aimed to evaluate the performance of patients with right hemisphere damage (RHD) with or without hemispatial neglect (HN) on a cancellation task. The study involved 31 control participants and 31 patients with RHD, matched by age, education, and frequency of reading and writing habits. The numbers of omission and random errors as well as the mean time to task completion were compared between adults with and without RHD, as well as between patients with and without HN. The latter made more left-sided omission errors, and more overall omission errors, than patients with RHD and no HN. The location of the first target canceled differed between subjects with RHD and control participants, as well as between patients with and without hemineglect. The use of organized vs. disorganized search strategies did not differ between groups. Further studies are required to investigate the performance of patients with HN of different levels of severity.

KEYWORDS
Damage; neuropsychological assessment; right-hemisphere hemispatial neglect; visual search

Introduction

Stroke is a major cause of disability in developed countries (Hoffmann, Bennett, Koh, & McKenna, 2010), and is strongly associated with impairments in cognitive functions such as memory, language, visuospatial orientation, and attention (Edwards, Jacova, Sepehry, Pratt, & Benavente, 2013). As such, stroke is associated with significant levels of disability in several aspects of daily life (Verdon, Schwartz, Lovblad, Hauert, & Vuilleumier, 2010). Cognitive impairments in patients with stroke may interfere with activities such as eating, writing, reading, getting dressed, and maintaining a social life (Azouvi, 2016; Azouvi et al., 2006; Hoffmann et al., 2010).

Attentional impairments are a common consequence of stroke, with prevalence estimates ranging from 46 to 92% in the acute phase (Loetscher & Lincoln, 2013). These alterations have an especially significant impact on patient functioning due to the known association between attention and daily functioning in patients with neurological conditions (Miloyan, Razani, Larco, Avila, & Chung, 2013). One of the most common attentional impairments observed in patients with a history of stroke is known as visual hemineglect, which is estimated to affect over 50% of patients (Bickerton, Samson, Williamson, & Humphreys, 2011; Duclos, Maynard, Abbas, & Mesure, 2014). This condition has long been a topic of interest in neurology and neuropsychology, as demonstrated by the detailed discussion of the condition in the seminal work of Critchley (1953) on the parietal lobes.

One of the most extensively studied subtypes of neglect in patients with a history of stroke is hemispatial neglect. This syndrome is often observed after right-hemisphere damage (Barker-Collo, Feigin, Lawes, Parag, & Senior, 2010; Jokinen et al., 2015), and is characterized by inadequate or absent responses to stimuli presented in the field of view that is contralateral to the lesion (Bickerton et al., 2011; Buxbaum, Dawson, & Linsley, 2012). Although it is often discussed as a purely attentional disorder, hemispatial neglect entails a constellation of neuropsychological impairments in perception and action (Vuilleumier & Saj, 2011). Additionally, the condition often involves nonspatially lateralized deficits, which may affect sustained and selective attention, as well as working memory (Van Vleet & DeGutis, 2013). These alterations are often dissociable, as has been noted in studies which found that visual-spatial training may improve performance on measures of hemispatial neglect but not on more

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general measures of attentional performance (Piccardi, Nico, Bureca, Matano, & Guariglia, 2006). Although progress has been made in the comprehension of spatial and nonspatial aspects of neglect, further studies are still required to shed light on the interaction between these components, especially given the heterogeneity in the presentation of hemispatial neglect in the affected population (Van Vleet & DeGutis, 2013).

In some cases, patients become unable to direct attention and action to one half of their bodies (personal hemineglect), while in others, they have trouble attending to stimuli in parts of their field of view (extra-personal hemineglect) (Azouvi, 2016). Other manifestations of unilateral neglect include hemialexia, or the tendency to read only the portion of a compound word located in the nonneglected hemifield (e.g., "foot" rather than "football"), and hemiacalculia, which can be observed by presenting patients with mathematical operations arranged in columns, and observing whether they only complete those located in the non-neglected hemifield (Cummings & Mega, 2003).

The main etiology of visual neglect is the damage to temporo-parietal regions, usually as the result of vascular conditions (Voos & Ribeiro do Valle, 2008). However, there does not appear to be a single critical lesion site for the condition. According to a recent meta-analysis, the regions associated with unilateral neglect include the posterior part of the superior longitudinal fasciculus, the inferior parietal lobule, the caudate nucleus, the superior temporal gyrus and sulcus, the insula and the middle occipital gyrus (Molenberghs, Sale, & Mattingley, 2012).

Some of these areas have been found to be associated with distinct manifestations of unilateral neglect. The inferior parietal lobule, for instance, has been identified as the neural substrate of perceptive or visuo-spatial components of the condition of neglect (Verdon et al., 2010). Extrapersonal space awareness, or the exploratory and visuo-motor components of neglect, have been linked to damage to the right dorsolateral prefrontal cortex (Committeri et al., 2007), while the temporal lobe has been found to be associated with allocentric or object-centered neglect (Verdon et al., 2010). Lastly, some of these regions have been found to be related to time-dependent features of neglect rather than the nature of the symptoms themselves. Damage to fronto-parietal and interhemispheric connections, especially the superior longitudinal fasciculus, have been implicated in the emergence and chronic persistence of neglect (Lunven & Bartolomeo, 2016; Molenberghs et al., 2012).

Neglect syndromes are more frequent in right-hemisphere damage as compared to left-hemisphere damage, due to the importance of the right parietal regions to the neural attention network (Lunven & Bartolomeo, 2016). This hemispheric asymmetry is explained in different ways by the most prevalent theories of attention. According to the hemispatial theory (Heilman & Van Den Abell, 1980), the right hemisphere is responsible for spatial attention in both visual hemifields, while the left hemisphere controls attention in the contralateral visual field only. The interhemispheric competition theory, on the other hand, suggests that the attentional control system relies on the cooperation of a complex system distributed across both hemispheres. However, it does hold that the right superior parietal lobule has a unique role in spatial attention, generating a higher attentional weight than the corresponding regions in the left hemisphere (Scolari, Seidl-Rathkopf, & Kastner, 2015). As such, regardless of the view adopted, it appears that the right hemisphere does make a unique contribution to neural attention networks.

The condition is diagnosed based on visuoperceptual and/or visual-motor tests. Several instruments have been developed to diagnose hemispatial neglect based on the identification of stimuli in the visual field. The most traditional methods of assessment are cancellation tasks (Gallagher, Wilkinson, & Sakel, 2013), figure copying (Yang, Zhou, Chung, Li-Tsang, & Fong, 2013), and drawing (Atalaia-Silva & Lourenço, 2008). Patients with hemispatial neglect following right-hemisphere damage tend to make omission errors on the left side of the page in cancellation tasks, or copy only half the clock-face on clock-drawing tests (Ciçek, Gitelman, Hurley, Nobre, & Mesulam, 2007; Siéroff, Decaix, Chokron, & Bartolomeo, 2007). Instruments such as the Rey-Osterrieth Complex Figure Test (Lezak, Howieson, Bigler, & Tranel, 2012) have also been reliably used to diagnose and characterize spatial neglect, as well as determine its severity in clinical samples (Knight & Kaplan, 2004; Luukkainen-Markkula, Tarkkab, Pitkanen, Sivenius, & Hamalainen, 2011b).

Comparisons of the diagnostic utility of different measures of hemineglect have revealed that cancellation tasks may provide the most reliable assessment of the condition (Alqahtani, 2015). Although line bisection is widely used to diagnose hemineglect in clinical settings, a recent evaluation of this task has revealed it may not be as accurate as cancellation or copying tasks in assessing either primary visual field deficits or spatial neglect (Sperber & Karnath, 2016). In addition to traditional scores, such as the number of omission errors, cancellation tests also allow for an assessment of visual search behavior. According to a study by Azouvi et al. (2002), the starting point in cancellation tests is the most sensitive indicator of hemispatial neglect in paper and pencil tasks.

One of the most widely used cancellation tests in the diagnosis of hemispatial neglect is the Bells Test (BT) (Gauthier, Dehaut, & Joanette, 1989). This instrument consists of 35 bell-shaped target stimuli, scattered on a horizontal sheet of paper in the midst of several distractors, in a pseudo-randomized distribution. The spatial distribution of cancelled targets and omission errors is then used to detect the presence of hemineglect (Jokinen et al., 2015). The instrument also contains an answer sheet on which the examiner can record the order in which the targets were cancelled and the location of the first target identified. This procedure reveals the search strategy used by the patient, allowing for the assessment of his visuospatial planning skills. Additional data regarding the efficiency of the patient's visual search strategy can be obtained by recording the time taken for the patient to complete the task.

The analysis of search strategies and the time taken to complete the task provide important data regarding the attentional performance of patients with different clinical conditions. According to recent studies, visual search strategies may differ between patients with different subtypes of hemineglect (Mizuno et al., 2016). However, no studies to date have investigated the level of organization and the characteristic features of search strategies used by patients in the BT (Wong et al., 2012).

Since the BT is among the most commonly used tools in the diagnosis of hemispatial neglect, the identification of additional variables on the instrument which may help characterize the disorder may have significant clinical implications. It may therefore be important to go beyond the distribution of omission errors and investigate the nature and efficiency of visual search strategies in patients with attentional impairments. This will allow studies to conduct further investigation into attentional planning and visuospatial processing in patients with hemispatial neglect, without the need for additional instruments or more extensive assessment batteries. This may contribute to the comprehension of hemineglect, and to the development of more effective interventions for patients with different types of attentional impairments.

In light of these observations, the aim of this study was to investigate visual search strategies in patients with right hemisphere damage, who show particularly high rates of hemispatial neglect (Lunven & Bartolomeo, 2016). This was achieved by comparing the attentional performance of patients with right hemisphere damage with and without hemineglect to that of control subjects.

Method

The sample consisted of 31 adult patients with right-hemisphere stroke confirmed by neuroimaging, and 31 healthy adults matched by age, education and frequency of reading and writing habits (FRWH), as analyzed by (Cotrena, Branco, Cardoso, Wong, & Fonseca, 2016; Pawlowski et al., 2012). Education was quantified in terms of the number of years of formal education, and the FRWH was measured on a scale ranging from 0 to 28. Patients are asked as to the weekly frequency with which they read books, magazines, newspapers and other materials, and write essays, notes and other types of text. Each item is rated on a Likert scale ranging from 0 ("never") to 4 ("everyday"), and ratings are summed to yield a final score. Patients ranged in age from 20 to 89 years, and had one to 20 years of formal education. Reading and writing scores ranged from 0 to 27.

The following exclusion criteria were applied: previous psychiatric illnesses; current or previous history of antipsychotic and/or illicit drug use; uncorrected visual or auditory impairments; multiple previous strokes; scores below the adjusted cut-offs for educational attainment on the Mini-Mental State Examination (MMSE) (Chaves & Izquierdo, 1992; Kochhann, Varela, Lisboa, & Chaves, 2010); and additional neurological disorders. Patients were also administered the Geriatric Depression Scale (Yesavage & Sheikh, 1986).

These criteria were screened using a sociodemographic questionnaire (Fonseca et al., 2012), resulting in the exclusion of four patients with a history of multiple strokes, and two with previous psychiatric hospitalizations. Two additional patients were removed from the sample after withdrawing consent for participation.

The same inclusion and exclusion criteria were applied to the control group, in addition to the absence of a history of stroke. Participants were also excluded from the control group if their scores on the Beck Depression Inventory-II (Cunha, 2001) were indicative of depression. Participants' clinical and demographic characteristics are shown in Table 1.

Control participants were selected by convenience, while patients with a history of stroke were recruited from hospital records or medical referrals. Participants were evaluated in well-lit, silent rooms, in a single assessment session lasting approximately an hour and a half. If any signs of fatigue were detected during testing, the session was interrupted and continued on a later date. Participants in the control group were selected from university, community, and professional settings.

Table 1. Demographic and clinical characteristics of the sample.

Variable	RHD M (SD)	Control M (SD)	F/x^2	p
Age	57.55 (13.78)	57.10 (14.73)	0.223	0.638
Education	10.19 (5.67)	10.42 (5.38)	0.122	0.728
FRWH	11.94 (7.00)	13.23 (6.45)	0.700	0.406
MMSE	26.45 (3.22)	28.00 (2.26)	7.743	0.007
SES	26.74 (7.28)	24.61 (5.61)	0.182	0.091
Gender F/M	17/14	25/6	0.056	0.028
Time since stroke	19.92 (19.11)	–		
MRS	1.48 (1.40)	–		
Depression severity*	n %	n %		
Absent	18 58.06	23 74.19		
Mild	6 19.35	8 25.80		
Moderate	2 6.45	0 0.00		
Severe	5 16.12	0 0.00		

Note. M = mean; SD = standard deviation; RHD = Right-hemisphere damage; F/M = Female/Male; MMSE = Mini-Mental State Examination; MRS = Modified Rankin Scale.

Procedures

All ethical guidelines for research involving human subjects were followed in the conduction of this study. The project was approved by a university ethics committee, and all participants provided written informed consent prior to the assessment.

Instruments

1. Bells Test (BT) (Gauthier et al., 1989), adapted to Brazilian Portuguese by Fonseca et al., in press. This instrument consists of an A4 sheet of paper, containing an array of several images, distributed across seven columns. In addition to the 35 target stimuli (bells), the test contains several distractors (e.g., trees, keys, clouds). The participant is asked to cross out any bells they see on the page. The number of omission errors on the left, right, and central columns, the total number of omission errors, the location of the first target cancelled, and the time taken to complete the instrument, are all recorded by the examiner. The search strategy used by the participant to cancel out the bells is also classified as organized (e.g., Left-right, right-left, up-down) or disorganized (chaotic).
2. Praxis Subtest (NEUPSILIN Brief Neuropsychological Assessment Battery) (Fonseca, Salles, & Parente, 2009). In this instrument, the patient is asked to copy three images: a square, a flower and a cube. He is also asked to draw an analog clock with the hands set to 3:45. The images are scored based on omission and rotation errors as well as their size.
3. Writing and drawing subtests from the Mini-Mental State Examination (MMSE) (Chaves & Izquierdo, 1992; Kochhann et al., 2010). In the writing subtest, the participant is asked to write a short sentence on a piece of paper. The drawing subtest requires that the patient copy a drawing of two overlapping pentagons.
4. Line Cancellation Subtest (NEUPSILIN Brief Neuropsychological Assessment Battery) (Fonseca et al., 2009). This instrument consists of an A4 sheet of paper containing several vertical lines. The participant is asked to draw a line across each of them. The number of omission errors is then recorded.

Data analysis

Two analyses were conducted: (1) comparison of speed, omission and commission errors between patients with RHD and control subjects; and (2) comparison of performance on the BT between patients with and without visual hemineglect. Data were analyzed using Student's T-test for independent samples. Performance on the BT was compared between patients with RHD and control subjects using a Mann-Whitney U test. Visual search strategies and the location of the first cancelled target were compared between groups using Chi-square tests.

Results

The characteristics of patients with a history of stroke are shown in Table 2. These data contain the information pertaining to both subsets of individuals with RHD (with and without hemispatial neglect).

Table 2. Clinical data: Patients with right-hemisphere damage.

Patient data	n	%
Type of stroke		
Ischemic	25	80.64
Hemorrhagic	2	6.45
N/R	4	12.90
Type of examination		
Computed tomography	10	32.25
Magnetic resonance imaging	10	32.25
Both	1	3.22
N/R	10	32.25
Hemineglect	7	22.58
Lesion location		
Pons + basal ganglia	1	
Frontal + insular cortex	1	
Basal ganglia	4	
Frontal	4	
Caudate nucleus + occipital	1	
Temporal + parietal + occipital	1	
Frontotemporal + insular cortex	1	
Thalamus	1	
Frontal + parietal	2	
Caudate nucleus	1	
Occipital	2	
Temporal	1	
Temporal + parietal	1	
N/R	8	

Note. N/R = not reported; MMSE = Mini-Mental State Examination; Praxis and line cancellation subtests from the NEUPSILIN Brief Neuropsychological Battery (Fonseca, Salles, & Parente, 2008).

Table 3. Comparison of patients with RHD and control subjects on the Bells Test.

Variables	RHD + HN M (SD)	RHD M (SD)	Control M (SD)	p	Post-hoc
Left-sided omissions	4.60 (6.15)	0.29 (0.69)	0.45 (1.06)	**0.003**	C, RHD < RHD + HN
Central omissions	1.60 (2.30)	0.04 (0.20)	0.03 (0.18)	**0.001**	C, RHD < RHD + HN
Right-sided omissions	2.00 (2.92)	0.25 (0.53)	0.19 (0.48)	**0.002**	C, RHD < RHD + HN
Total number of omission errors	8.20 (8.90)	0.58 (2.83)	0.68 (1.30)	**0.009**	C, RHD < RHD + HN
Total number of commission errors (distractors)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.000	–
Time	256.06 (47.61)	224.74 (82.29)	140.04 (42.61)	**0.000**	C < RHD, RHD + HN
First bell cancelled in first column from left (*n*;%)	20 (64.5%)	5 (20.8%)	3 (42.9%)	**0.004**	–
Organized search strategy (*n*;%)	28 (90.3%)	19 (19.7%)	4 (57.1%)	0.088	–

Note. $p = 0.05$.

As shown in Table 2, seven patients showed performance impairments indicative of hemineglect. Patients with RHD were therefore divided into two groups based on the presence or absence of this condition.

All patients in the hemineglect group showed impairments on at least two diagnostic instruments (BT, line cancellation, figure copying – praxis, and writing and drawing on the MMSE). However, no single instrument was able to detect hemineglect in all seven cases. The BT proved to be most sensitive to hemineglect, detecting the condition in six of the seven patients in this group. Three met criteria for hemispatial neglect on the figure copying/praxis and line cancellation subtests of the NEUPSILIN. Lastly, only two of the seven patients displayed symptoms of hemispatial neglect on the MMSE.

In addition to contributing to the diagnosis of hemispatial neglect, the BT provides additional information regarding attentional performance, including visual search strategies and omission errors per region of the visual field. Additionally, the time taken to complete the test can be interpreted as an indicator of performance efficiency. As such, these scores were compared between participant groups to reveal additional differences in attention between control subjects and individuals with RHD with and without spatial hemineglect. The results of these comparisons are shown in Table 3.

As can be seen in Table 3, several differences in attentional performance were apparent between the two groups of patients with RHD and the control participants. The number of omission errors in the left, right and center of the page, as well as the total number of omission errors, was significantly higher for patients with hemineglect than subjects in all other participant groups. Commission errors were not reported in any participant group. Interestingly, the time taken to complete the test also differed between groups, and was significantly longer for both groups of patients with RHD relative to the control group.

Lastly, although no significant differences were observed in the use of organized *vs.* disorganized search strategies, the location of the first target cancelled did differ across the sample. The location of the first canceled target was coded as a dichotomous variable (column 1 vs. columns 2–7). This variable differed significantly between groups. The number of patients in the control group who began the task on the first column from the left appeared to be significantly higher than the corresponding figure in the other participant groups.

While the number of patients within the hemineglect group did not provide sufficient statistical power for any intra-group analysis, a qualitative assessment of their performance on the BT revealed significant variability in their attentional patterns. Four of the seven patients with the condition made a larger number of errors on the left side of the page, while 2 made a similar number of errors on both sides of the test, and one made more omission errors on the right side of the instrument (ipsilateral).

Discussion

The aim of this study was to investigate the attentional performance of patients with and without hemineglect following RHD. As such, we compared control subjects to two groups of patients with RHD: one with hemispatial neglect, and the other with no symptoms of this condition. These comparisons revealed significant differences in the speed and accuracy of attentional performance between all three participant groups. The analysis of participant performance on a cancellation task revealed that, in addition to a higher number of omission errors in the hemifield contralateral to the lesion, as was expected, patients with hemispatial neglect displayed more omission errors in other regions of the visual field. Additionally, while patients with RHD and no hemispatial neglect did not differ from control participants in the number of omission or commission errors in the cancellation test, they took much longer to complete it. These findings make for important considerations regarding the neuropsychological assessment of hemispatial neglect and attention in RHD.

The difference in the number of left-sided omission errors between control participants and subjects with hemispatial neglect was expected, and corroborated the findings of several studies involving the BT (Bickerton et al., 2011; Jokinen et al., 2015). However, these individuals also missed a significantly larger number of targets than remaining participants in the right and center of the stimulus array. These findings are indicative of impairments in selective attention which are not exclusively attributable to the presence of neglect, and corroborate previous findings regarding the presence of nonspatially lateralized deficits in patients with this condition (Van Vleet & DeGutis, 2013). As such, in addition to undergoing regular visual spatial treatment, patients with hemispatial neglect should also receive treatment for selective attention deficits in the visual field as a whole. Such interventions may be especially beneficial given the poor generalization of visual spatial treatment to other types of attentional impairment (Piccardi et al., 2006).

Results regarding the number of omission errors in patients with RHD and no hemispatial neglect were also partly corroborated by the literature. Although, unlike previous studies, we did not identify significant differences between these individuals and a control group in the number of omission errors (e.g., Bickerton et al., 2011; Suchan, Rorden, & Karnath, 2012), they did differ from patients with hemispatial neglect on this measure, corroborating previous studies in the literature (Jokinen et al., 2015).

In addition to evaluating the number of omission errors made by patients with RHD in the cancellation test, we also analyzed participant performance in terms of the search strategies used and the time taken to complete the test. While the use of organized search strategies did not differ between groups, both sets of patients with RHD (with and without hemineglect) were less likely than control participants to start the task on the first column of the stimulus array. Neurologically healthy adults often begin a visual search task from the left side of the page, and continue to follow this pattern as it mirrors the visual search processes involved in reading in left-to-right languages (Laurent-Vannier, Chevignard, Pradat-Diehl, Abada, & De Agostini, 2006). However, in the present study, this behavior was not observed in patients with RHD, regardless of the presence of hemispatial neglect. The starting point in a cancellation task has been found to be a more sensitive indicator of attentional impairment than the number of omissions on the BT (Azouvi et al., 2006). As such, this corroborates the presence of attentional impairments in patients with hemineglect, but also suggests that the remaining patients may be experiencing mild attentional deficits, despite showing no difference from control subjects in the number of omission or commission errors on the cancellation task.

Lastly, the three participant groups were compared in terms of the time taken to complete the cancellation test. Interestingly, both groups of patients with RHD took significantly longer to complete the assessment than subjects in the control group. An absence of differences between patients with and without hemispatial neglect in the time taken to complete the task has already been reported in previous studies (Bickerton et al., 2011). These findings suggest that patients with RHD may show impairments in the efficiency of visual processing regardless of the presence of hemispatial neglect. This may be associated with the use of poor visual search strategies, as may be inferred from their decreased likelihood of starting the task from the left side of the page. Though this hypothesis must still be confirmed by additional studies, it has important implications for the comprehension and clinical management of attentional impairments following RHD.

The present findings must be interpreted in light of some limitations. The severity of hemispatial neglect and the use of medication were not controlled in the analyses. The degree of neglect severity is associated with individual variations in performance on attentional tests (Luukkainen-Markkula, Tarkka, Pitkänen, Sivenius, & Hämäläinen, 2011a), and may have contributed to between-group differences on these measures. The use of noradrenergic or dopaminergic medications could also have influenced findings, since attentional performance in hemineglect has also been found to be modulated by both types of drug (Gorgoraptis et al., 2012; Malhotra, Parton, Greenwood, & Husain, 2006). However, it is important to note that patients were specifically screened for antipsychotic use, eliminating an important drug-related confounding factor from the present study. Lastly, due to our small sample size, we were unable to analyze the influence of variables such as the time since stroke, which is known to have an impact on visual search tasks, and lesion location.

Despite these limitations, the present study made important contributions to the literature. Patients with RHD, regardless of hemineglect, took longer to complete a cancellation task, and were less likely to begin their visual search from the top left corner, as do most control participants. This suggests a lower efficiency of attentional processing in patients with RHD overall, possibly associated with difficulties identifying and selecting an effective visual search strategy. Additionally, patients with hemispatial neglect showed impairments in overall selective attention which were not limited to the hemifield contralateral to the lesion.

The clinical implications of these results extend to both neuropsychological assessment and rehabilitation. The assessment of patients with RHD should continue to include cancellation instruments to evaluate attention and hemineglect, but must be analyzed in terms of the search strategies used in addition to commission and/or omission errors. Similarly, rehabilitation programs for patients with RHD must combine traditional approaches such as sustained attention training with the exploration of selective attention and visual search strategies, teaching patients to monitor their performance, evaluate their strategies, and develop more effective ones, if necessary.

Future studies should seek to investigate other populations such as those with left-hemisphere damage or hemispatial neglect of different etiologies and levels of severity, so as to better comprehend the visual search process in these conditions. Additionally, studies should include ecological assessment instruments to verify the impact of attentional impairments on functional capacity. The results of these studies could contribute to the comprehension of functional impairments reported by patients after stroke, resulting in more effective and specific interventions, and, consequently, greater benefits to patient functioning and quality of life.

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