

# Fluctuation in Spontaneous Recovery of Left Visual Neglect: A 1-Year Follow-Up

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## Key Words

Recovery from stroke · Visual neglect

## Abstract

Spontaneous recovery and possible fluctuation in left visual neglect, and its relation to stroke severity, basic activities of daily living (ADL) and extended ADL were examined at 10 days, at 3, 6, and 12 months after onset. Twenty-one of 56 right hemisphere stroke patients had visual neglect. Three visual neglect recovery groups were identified: continuous, fluctuating and poor recovery. We concentrated on the comparison of the continuous and the fluctuating recovery groups. At the acute phase the fluctuating recovery group had larger infarcts, more severe neglect and stroke, and a lower level of basic ADL compared to the continuous recovery group. In the continuous recovery group stable recovery was detected up to 6 months, whereas in the fluctuating recovery group recovery was incoherent in neglect and in extended ADL. A minimum follow-up period of 6 months including the evaluation of extended ADL is recommended for neglect patients due to possible fluctuation in visual neglect.

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## Introduction

Neglect refers to a difficulty in detecting, acting on or even imagining information from a contralateral space of lesion that cannot be fully accounted for by basic sensory or motor loss [1, 2]. In population-based studies the incidence of neglect is on average 25% in the acute stage [3, 4], and it is more common and severe following right than left hemisphere damage [2]. In right hemisphere stroke patients the reported incidence of neglect varies from 13 to 82% [5]. The presence of neglect has been connected with poor functional recovery and difficulties in activities of daily living (ADL) [6–9], although controversial findings about the independent effect of neglect on poor functional outcome have been presented [3, 10]. Neglect may recover spontaneously, its recovery may be partial, or it may show brief remission periods [11–15]. Some studies suggest that visual neglect resolves within 2 months after onset [13, 16] or between 3 and 6 months after onset [6, 14, 17, 18], while others report that it may persist from 1 year up to several years [8, 19, 20]. A few studies have reported fluctuation in the spontaneous recovery of neglect [11, 12]. For example, Levy et al. [12] found minimal fluctuation in visual neglect in a small subgroup of chronic neglect patients (n = 4). Recovery of visual neglect was evaluated twice a day using the Behav-

Journal Inattention Test (BIT) [21]. They suggested that variation in visual neglect may be due to learned strategies. Small and Ellis [11] reported occasional transitory improvement in left visual neglect. Their study group consisted of 7 patients of which 3 showed wide variations in visual neglect, 2 showed steady improvements in visual neglect, and 2 had severe neglect during the follow-up. Neglect was assessed using the conventional subtests of the BIT (BITC) at weekly intervals for a period of 2.5–14 months.

The aim of our study was to examine the spontaneous recovery of left visual neglect during a year after stroke. We were particularly interested in the possible fluctuation in visual neglect, and its relation to stroke severity and ADL in patients who had suffered first stroke. To the best of our knowledge there is relatively little research on fluctuation in visual neglect and its relation to functional outcome.

## Methods

This study included 56 consecutive patients with first acute right hemisphere brain infarct. Patients with previous neurological disorders, severe primary visual impairment, left-handedness and age over 75 years were excluded. Infarct sizes were determined at the acute phase (mean = 6.0 days; range = 0–12) on the basis of T<sub>2</sub>-weighted MRI images by manual tracing or, when digital images were not available, on the basis of CT images using a method described by Broderick et al. [22]. For 2 patients lesion size could not be calculated. Neuropsychological and neurological assessments were conducted on average 6 days after onset (range = 3–10 days). Follow-up studies were performed at 3, 6 and 12 months after stroke and were conducted for all the patients at the same time of day. None of the patients had recurrent strokes.

In the 10-day examination 21 of the 56 patients had visual neglect. The recovery of visual neglect was determined on the basis of the neglect patients' BITC sum scores at each examination. Three visual neglect recovery groups were identified: (a) continuous recovery group (CR; *n* = 12), (b) fluctuating recovery group (FR; *n* = 4), and (c) poor recovery group (PR; *n* = 5). Patients in the CR group exceeded the cutoff score of BITC (>129) at a certain time-point and subsequently remained above it, indicating steady recovery. Patients in the FR group exceeded the cutoff score of BITC at some time-points and at others fell short of it, indicating unstable neglect recovery. Patients in the PR group did not reach the cutoff score at any time-point and still showed severe neglect at 12 months. In the PR group 1 patient died and 2 refused to take part after the 3-month follow-up.

The degree of stroke severity, hemianopia and motor defect was evaluated using the National Institute of Health Stroke Scale (NIHSS) [23]. Basic ADL was evaluated with the Barthel Index (BI) [24]. Patients were categorized as having minor or no dependence (BI ≥ 80) or major dependence (BI < 80) in basic ADL. Extended ADL was assessed using the Frenchay Activities Index (FAI) [25]. At the acute phase patients evaluated the frequency of

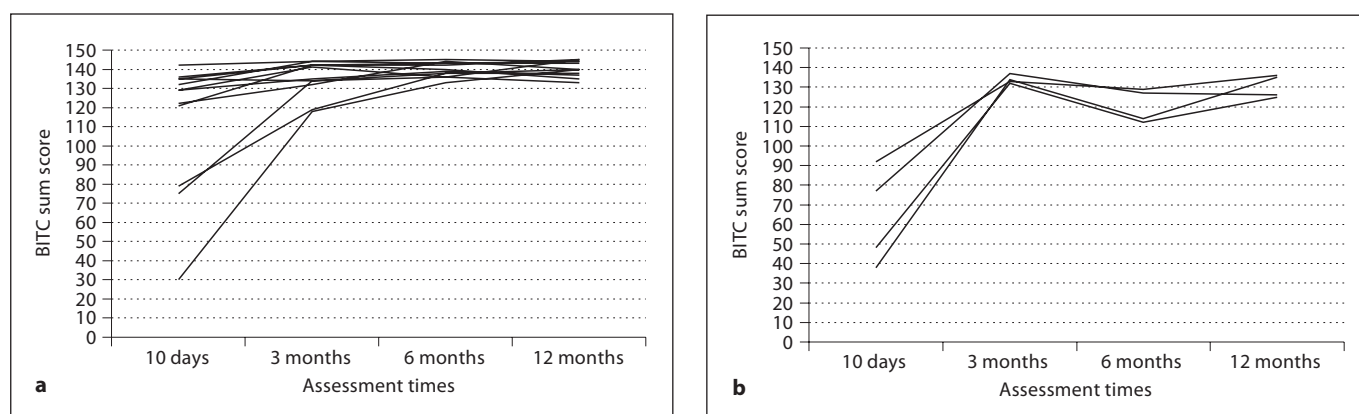
each activity prior to stroke, which was set as a baseline criterion (median FAI score for each neglect recovery group) for good functional ability. Detailed description of tests, their administration and scoring are given elsewhere [8].

Nonparametric methods were used because of the shape of the distributions of variables and because of the small sample sizes. Differences in continuous variables between the neglect recovery groups were analyzed using either Kruskal-Wallis analysis of variance (when comparing three groups) or Mann-Whitney U test (when comparing two groups). Cross tabulations and exact  $\chi^2$ -test were used for categorical variables. Changes between more than two time-points were analyzed using the Friedman test; thereafter the Wilcoxon test was used to detect differences between two time-points. All reported *p* values are based on two-tailed tests. Because of the small sample sizes, we also paid attention to *p* values between 0.05 and 0.1, which are reported as non-significant trends.

## Results

The patient characteristics are given in table 1. At the acute phase patients in the PR group were older ( $\chi^2 = 7.134$ , d.f. = 2, *p* = 0.028), less educated ( $\chi^2 = 5.586$ , d.f. = 2, *p* = 0.061), had more often hemiparesis ( $\chi^2 = 5.452$ , exact *p* = 0.084) and hemianopia ( $\chi^2 = 7.275$ , exact *p* = 0.031) than patients in the other two groups. Infarct size did not differ significantly between the three groups, although median infarct sizes were considerably smaller in the CR group. Since sample size decreased markedly in the PR group after the 3-month follow-up, we concentrated on comparing the recovery of the FR and the CR groups. Patients in the FR group had larger infarcts than patients in the CR group (*U* = 6.000, *p* = 0.048), but the groups did not differ significantly according to age, length of education, hemianopia or hemiparesis.

Individual recovery profiles of visual neglect (BITC) for patients in the CR and in the FR groups are given in figure 1. Table 2 summarizes the presence of visual neglect (BITC), stroke severity (NIHSS), and the level of basic (BI) and extended (FAI) ADL in both groups. The FR group had more severe neglect at the acute phase (*U* = 7.000, *p* = 0.039), at 6 months (*U* = 0.000, *p* = 0.004) and at 12 months (*U* = 3.500, *p* = 0.012) when compared to the CR group. In the CR group (*z* = -2.848, *p* = 0.004) and in the FR group (*z* = -1.826, *p* = 0.068) visual neglect recovered within 3 months (10 out of 12 patients in the CR group, and all in the FR group). At 6 months the remaining 2 patients in the CR group recovered and no neglect was detected thereafter, whereas in the FR group all the patients had visual neglect at 6 months, and at 1 year 2 patients still showed visual neglect.



**Fig. 1.** Individual recovery profiles of visual neglect (BITC sum scores) in the continuous (**a**,  $n = 12$ ) and in the fluctuating (**b**,  $n = 4$ ) recovery groups during the 1-year follow-up. Range 0–146. The cutoff score for visual neglect is 129 (0–129 = neglect; 130–146 = normal).

**Table 1.** Patient characteristics in the visual neglect recovery groups at the acute phase

Descriptive variable	Neglect recovery groups		
	CR ( $n = 12$ )	FR ( $n = 4$ )	PR ( $n = 5$ )
Age, years	59.0 (57; 64)	63.5 (38; 66)	73.0 (67; 75)
Sex (M/F)	7/5	3/1	2/3
Education, years	8.5 (7; 10)	8.5 (7; 10)	7.0 (6; 8)
Hemiparesis: present	5	3	5
Hemianopia: present	3	0	4
Infarct size, $\text{cm}^3$	72.8 (61; 113) <sup>a</sup>	172.2 (99; 241)	178.8 (68; 313)

For age, education and infarct size medians are given (lower quartile and upper quartile in parentheses).

<sup>a</sup> Two patients had missing values.

At the acute phase the FR group had more severe stroke ( $U = 7.000$ ,  $p = 0.049$ ) than the CR group, but the groups did not differ at the follow-ups. In the CR group stroke severity recovered significantly between 10 days and 3 months ( $z = -2.611$ ,  $p = 0.009$ ), and between 3 months and 6 months ( $z = -2.395$ ,  $p = 0.017$ ), but no significant change occurred after 6 months. In the FR group a nonsignificant trend towards recovery in stroke severity was found between 10 days and 3 months ( $z = -1.826$ ,  $p = 0.068$ ), and after that stroke severity remained stable.

Patients in the FR group seemed to be more dependent in basic ADL ( $U = 10.000$ ,  $p = 0.086$ ) at the acute phase when compared to the CR group, but the groups did not differ at the follow-ups. In basic ADL a significant improvement in the CR group was found between 10 days and 3 months ( $z = -2.375$ ,  $p = 0.018$ ), and between

3 months and 6 months ( $z = -2.207$ ,  $p = 0.027$ ). After 6 months all patients were independent in basic ADL. In the FR group a minor nonsignificant improvement in basic ADL was found between 10 days and 3 months ( $z = -1.826$ ,  $p = 0.068$ ), but thereafter no improvement was detected.

At the acute phase the baseline FAI (patients' evaluation of extended ADL prior to stroke) did not differ between the groups. However, the recovery in extended ADL between the groups seemed to differ at each follow-up according to the median FAI scores, although the differences were not significant. A significant recovery in extended ADL was seen in the CR group between 3 and 6 months ( $z = -2.652$ ,  $p = 0.008$ ), and the median FAI score at 6 months nearly reached the baseline level. However, a significant decline in extended ADL was found

**Table 2.** Median (Q<sub>1</sub>; Q<sub>3</sub>) sum scores of BITC, BI, FAI and NIHSS and the frequency of hemianopia and hemiparesis at each assessment in CR and FR groups

Recovery group	Assessment time			
	10 days	3 months	6 months	12 months
CR group (n = 12)				
BITC	129 (90; 135)	138 (133; 142)	140 (137; 143)	140 (137; 144)
BI	58 (36; 100)	93 (53; 100)	100 (90; 100)	100 (81; 100)
FAI	46 (41; 51) <sup>a</sup>	34 (23; 41)	42 (32; 46)	36 (25; 44)
NIHSS	5 (3; 9)	5 (1; 8)	3 (1; 6)	5 (1; 6)
Hemianopia: present	3	0	0	0
Hemiparesis: present	5	6 <sup>b</sup>	6 <sup>b</sup>	6 <sup>b</sup>
FR group (n = 4)				
BITC	63 (41; 88)	134 (132; 136)	121 (113; 129)	131 (125; 136)
BI	30 (21; 43)	88 (54; 95)	90 (81; 99)	95 (84; 99)
FAI	38 (32; 47) <sup>a</sup>	23 (19; 37)	27 (24; 41)	27 (21; 42)
NIHSS	12 (7; 14) <sup>c</sup>	4 (3; 6)	3 (2; 6)	3 (1; 6)
Hemianopia: present	0	0	0	0
Hemiparesis: present	3	2	2	2

Q<sub>1</sub> = Lower quartile; Q<sub>3</sub> = upper quartile. BITC: range 0–146; 0–129 = neglect, 130–146 = no neglect. BI: range 0–100; 0 = dependent, 100 = independent. FAI: range 14–56; 14 = poor functional ability, 56 = good functional ability. NIHSS: range 0–34; 0 = no defect, 34 = severe stroke.

<sup>a</sup> 10-day FAI sum score is based on patient evaluation of the frequency of activities prior to stroke.

<sup>b</sup> Fluctuation in the number of hemiparetic patients between the 10-day examination and the three follow-ups is due to 1 patient's score that changed slightly without recurrent stroke.

<sup>c</sup> One case is missing.

between 6 months and 12 months ( $z = -2.280$ ,  $p = 0.023$ ). In the FR group the level of extended ADL remained clearly below baseline, and no significant recovery was detected during the follow-up.

## Discussion

The purpose of this study was to examine spontaneous recovery and the possible fluctuation in visual neglect in relation to stroke severity and ADL functioning during a 1-year follow-up. The study was conducted among a homogeneous group of consecutive patients having their first right hemisphere infarct. Three visual neglect recovery groups were identified: (a) CR, (b) FR, and (c) PR. We identified an FR group, which is in line with previous studies [11, 12], and whose recovery of left visual neglect was periodically interrupted and did not proceed steadily. Special attention was paid to the comparison of FR and CR groups.

At the acute phase the FR group had more severe neglect and more severe stroke. They also had larger infarcts and seemed to be more dependent in basic ADL

than patients in the CR group. The CR group showed stable recovery of visual neglect and extended ADL within 6 months, whereas in the FR group the recovery in neglect was incoherent, and no recovery in extended ADL was detected. The FR group had poorer functional ability in the extended ADL according to the median FAI scores during follow-up. Recovery in stroke severity and basic ADL did not differ and was stable in the two groups. On the basis of these results one may argue that the fluctuation in neglect has no profound effect on basic ADL skills but it may manifest itself in extended ADL, although one must be cautious about generalizing the results of a small patient group.

To the best of our knowledge there is no consensus about the factors that may cause the fluctuation in visual neglect [11–13]. Small and Ellis [11] reported similar profiles in neglect recovery in 7 stroke patients. Their study included confounding factors that may have influenced their results: advanced age, poor visual acuity, irregular follow-ups, recurrent strokes, and a selected patient sample. In our study these factors were controlled in a larger group of left neglect patients, who were examined at the same time of day, but still fluctuation in neglect recovery

was found, indicating that these factors may not be the primary cause of fluctuation in neglect. According to our results the fluctuation in visual neglect may be explained in part by the baseline factors (size of infarct, severity of stroke, level of basic ADL). Especially large infarcts which are known to be associated with persistent neglect [13] may be one explanatory factor for the fluctuation of visual neglect. Interestingly, in the FR group visual neglect, stroke severity and basic ADL recovered up to 3 months, but during that period a similar tendency was not detected in the recovery of extended ADL. This may be due to structured circumstances in neuropsychological examination in which the patient may have been able to compensate for possible residual neglect, but not in more complex everyday activities. This supports the argument of Levy et al. [12], who assumed that fluctuation in neglect in convalescent patients may be caused by learned strategies.

Our results indicate that the presence of fluctuation may be indicative of residual neglect, which may have an impact especially on patients' extended ADL functions, such as working, managing in social situations or behaving in traffic. A limitation of this study is the small number of patients in the FR group, which may undermine the generalizability of the results. Future research should aim at determining if learning and compensation, possible tiredness, and/or previous activities cause the fluctuation in a patient's neglect. Also the impact of the baseline factors (e.g. size of infarct, severity of stroke, level of basic ADL) on the fluctuation of neglect should be examined in a larger patient group. A minimum follow-up period of 6 months after acute neglect is supported by the fact that during that period recovery can be detected in neglect, in stroke severity, and in basic and extended ADL. The assessment of extended ADL skills should also be included in the evaluation of neglect recovery.

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