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Research report

Anosognosia, neglect, extinction and lesion site predict impairment of daily living after right-hemispheric stroke

Simone Vossel [a,*], Peter H. Weiss [a,b], Philipp Eschenbeck [a,c] and Gereon R. Fink [a,b]

[a] Cognitive Neuroscience, Institute of Neuroscience & Medicine (INM-3), Research Centre Jülich, Jülich, Germany
[b] Department of Neurology, University Hospital Cologne, Cologne, Germany
[c] Hochschule für Gesundheit, University of Applied Sciences, Bochum, Germany

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ABSTRACT

Introduction: Right-hemispheric stroke can give rise to manifold neuropsychological deficits, in particular, impairments of spatial perception which are often accompanied by reduced self-awareness of these deficits (anosognosia). To date, the specific contribution of these deficits to a patient's difficulties in daily life activities remains to be elucidated.

Methods: In 55 patients with right-hemispheric stroke we investigated the predictive value of different neglect-related symptoms, visual extinction and anosognosia for the performance of standardized activities of daily living (ADL). The additional impact of lesion location was examined using voxel-based lesion-symptom mapping.

Results: Step-wise linear regression revealed that anosognosia for visuospatial deficits was the most important predictor for performance in standardized ADL. In addition, motor-intentional and perceptual-attentional neglect, extinction and cancellation task performance significantly predicted ADL performance. Lesions comprising the right frontal and cingulate cortex and adjacent white matter explained additional variance in the performance of standardized ADL, in that damage to these areas was related to lower performance than predicted by the regression model only.

Conclusion: Our data show a decisive role of anosognosia for visuospatial deficits for impaired ADL and therefore outcome/disability after stroke. The findings further demonstrate that the severity of neglect and extinction also predicts ADL performance. Our results thus strongly suggest that right-hemispheric stroke patients should not only be routinely assessed for neglect and extinction but also for anosognosia to initiate appropriate rehabilitative treatment. The observation that right frontal lesions explain additional variance in ADL most likely reflects that dysfunction of the supervisory system also significantly impacts upon rehabilitation.

* *Corresponding author*. Cognitive Neuroscience, Institute of Neuroscience and Medicine (INM-3), Research Centre Jülich, Leo-Brandt-Str. 5, 52425 Jülich, Germany.
E-mail address: s.vossel@fz-juelich.de (S. Vossel).
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1. Introduction

Right-hemispheric stroke frequently gives rise to severe impairments of visuospatial processing resulting in spatial neglect or extinction. While neglect patients generally show reduced awareness for contralesional sensory events, extinction patients fail to respond to contralesional events when simultaneous ipsilesional stimulation is present (Vossel et al., 2011). Furthermore, neglect is a multifaceted disorder and can, for example, differentially affect perceptual-attentional as well as motor-intentional functions (e.g., Bisiach et al., 1998; Vallar, 2001; Vossel et al., 2010). Right-hemispheric lesions and neglect are moreover closely associated with anosognosia for both motor impairment (Pia et al., 2004; Orfei et al., 2007) and visuospatial deficits (Vossel et al., 2012), so that the patients show reduced self-awareness for their stroke-induced functional impairments.

While the cognitive processes and the underlying lesion anatomy of each of the above-mentioned symptoms and syndromes after stroke have been investigated by several studies, their functional significance for activities of daily living (ADL) to date remains less clear. For example, while paper-and-pencil or computer-based tests of neglect or extinction might be very sensitive in detecting visuospatial impairment, whether and how such deficits translate into difficulties in day-to-day activities remains to be established. In a previous study, we could show that performance in paper-and-pencil neglect tests and performance in standardized ADL correlate significantly, suggesting considerable ecological validity of the conventional paper-and-pencil neglect tests (Eschenbeck et al., 2010; see also Azouvi et al., 2002; Wilson et al., 1987a). However, despite the close relation of task performance in both test batteries, a considerable amount of patients showed neglect in neuropsychological tests, but not in standardized ADL (while the reverse pattern was observed in one of the examined patients only; Eschenbeck et al., 2010; see Wilson et al., 1987a for similar results). Hence, not all deficits that are detected by neuropsychological paper-and-pencil tests translate into impaired ADL.

The present study used a step-wise linear regression analysis to investigate how different neglect-related symptoms (as assessed with paper-and-pencil tests), visual extinction (as assessed by a computer test), as well as the self-awareness for visuospatial deficits (i.e., anosognosia) impact on the performance in standardized ADL. Though it is well established that the presence of neglect significantly impacts upon rehabilitation (Jehkonen et al., 2006; Stone et al., 1992), the influence of extinction or anosognosia for neglect upon ADL or rehabilitation to date has hardly been investigated. In the tactile modality, one study has already provided preliminary evidence for a significant impact of extinction for predicting a patient's functional status (Rose et al., 1994). The present study moreover used statistical voxel-based lesion mapping to test whether lesion site can explain additional variability in ADL performance over and above what is explained by the neuropsychological predictors.

2. Methods

2.1. Patient sample

Sixty-eight patients with clinically diagnosed right-hemispheric stroke were consecutively recruited from the Department of Neurology, University Hospital Cologne, or the Neurological Rehabilitation Centre, Bonn. All patients gave written informed consent before participating in the study. The study was carried out in accordance with the ethical principles of the World Medical Association (Declaration of Helsinki) and was approved by the ethics committee of the Medical Faculty in Cologne. To be enrolled, subjects had to be between 18 and 80 years, and right-handed. Patients were excluded if they showed signs of dementia or otherwise limited cognitive function [as indexed by a score below 25 in the Mini Mental State Examination (MMSE; Folstein et al., 1975)], or if the patient's anamnesis revealed evidence for a history of psychiatric disorders including alcohol/drug abuse. Moreover, patients were excluded when they reported not to see the left-sided stimuli with central fixation in the computerized extinction task due to a visual field defect (see Vossel et al., 2011). Five patients were excluded after enrolment due to old left-hemispheric lesions. The patient sample had already contributed to previous studies (Eschenbeck et al., 2010; Vossel et al., 2010, 2011, 2012).

Complete data sets including all tests of interest for the present study were available for 55 patients. These data were analysed. Lesions were confirmed by computerized tomography (CT) or magnetic resonance imaging (MRI). Table 1 provides an overview over the demographic and clinical characteristics of the patients.

To further investigate putative effects of time post-stroke in the present dataset, patients were additionally divided into three subgroups: group 1 (<1 month after stroke, $n = 31$), group 2 (>1 month but <3 months after stroke, $n = 13$), group 3 (>3 months after stroke, $n = 11$). Using one-way analyses of variance (ANOVAs), we tested for differences in our independent and dependent variables, as well as for differences in the residuals of the regression model.

2.2. Standardized ADL

The patients completed 8 standardized ADL (cf. Eschenbeck et al., 2010):

Table 1 – Demographic and clinical data of the patient sample.

Age	59.3 ± 13.4 years (SD)
Gender	9 females/46 males
Aetiology	48 ischemic/7 hemorrhagic
Time post-stroke	114.9 ± 244.7 days
MMSE score	28.52 ± 1.34
Paresis of the contralesional side	46 patients (83.6%)
Contralesional somatosensory deficits	25 patients (45.5%)
Evidence for possible anosognosia for hemiparesis	10 patients (18.2%)