Neuropsychological rehabilitation

Stephanie Clarke
Claire Bindschaedler
Sonia Crottaz-Herbette

Service de Neuropsychologie et de Neuroréhabilitation, CHUV
Lausanne, Switzerland

Stephanie.Clarke@chuv.ch

UNIL | Université de Lausanne

Disclosure

Own research described here was financed by the Swiss National Science Foundation: grants to S. Clarke and S. Crottaz-Herbette

No other financial support

Learning objectives

How to conceive of hemispatial neglect in terms of cognitive models and their impact of rehabilitation

Diagnostic tools for neglect

Anatomo-clinical correlations

Hemineglect = a modular deficit

Recovery

Rehabilitation

- **Cognitive models**
- **Effectiveness**

Key message - I

Over the last two decades cognitive neuroscience brought new insights to several fields of high clinical relevance. There is a general consensus that stroke rehabilitation benefits from this development (Clarke et al. 2015). We will outline how recent developments influence the rehabilitation of cognitive functions on the example of left unilateral neglect, which is a complex clinical syndrome (Clarke and Bindschaedler 2014). As demonstrated in seminal studies neglect is a modular deficit, which can affect different aspects of visual, auditory, somatosensory and motor processing. Clinical studies have well demonstrated that the presence of neglect beyond the acute stage is generally associated with poor outcome in terms of independence..

Key message - II

We will review current evidence, which strongly suggests that neglect rehabilitation leads to better outcome. Significant improvement has been documented in prospective randomised studies for several therapeutic interventions, including combined training of visual scanning, reading, copying and figure description; trunk orientation plus visual scanning training; neck muscle vibration plus visual exploration training; visual scanning training alone; spatiomotor cueing with limb activation; right hemifield or right eye patching; and prism adaptation training. There is, however, a need for further studies, with activities of daily living as primary outcome and with long-term follow-up. Furthermore, the indications for specific treatments will need to be defined in terms of neglect types.

For further reading see also

Clarke, S., Bindschaedler, C. (2014) Unilateral neglect and anosognosia. In Selzer M. E., Clarke S., Cohen L. G., Kwakkel G., Miller R.H. (eds) Textbook of Neural Repair and Rehabilitation. Volume II, 2nd edition, Cambridge University Press, 463-477.

Clarke S, Bindschaedler C, Crottaz-Herbette S (2015) Impact of cognitive neuroscience on stroke rehabilitation. Stroke 46:1408-13

Neglect rehabilitation

- Diagnosis
- Anatomo-clinical correlations
- Hemineglect = a modular deficit
- Recovery
- Rehabilitation
  - Cognitive models
  - Effectiveness

Diagnosis

- **Right-hemispheric lesion**
- **Lack or decrease of attention to stimuli and events on the left-hand side**
  - **No reaction when spoken to from the left side**
  - **Not eating food on the left half of plate**
  - **Not shaving left half of face**
  - **Not reading left half of the newspaper**
  - **More subtle deficits later**
- **Visual, auditory, somatosensory, motor modalities can be affected to varying degree (Barbieri & De Renzi 1989)**
- **Formal testing**
  - **Cancelling tests, line bisection, simultaneous visual stimulation, copy, drawing**
  - **Dichotic listening**
  - **Simultaneous tactile stimulation**

Anatomoclinical correlations

Right hemisphere

Brain 1941

McFie et al. 1950

Inferior parietal lobule

Vallar & Perani 1986

Frontal lobe; inferior frontal gyrus

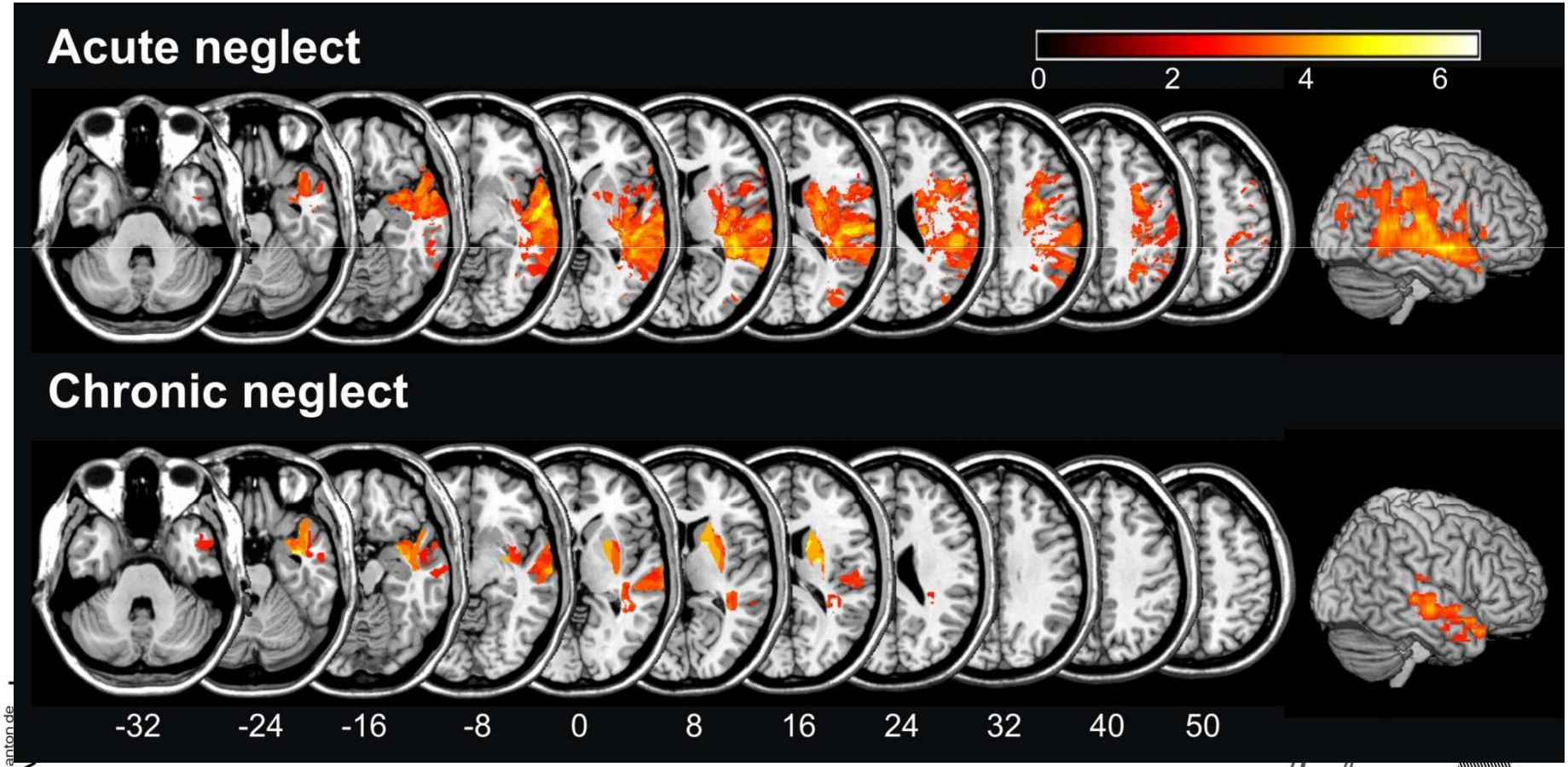
Heilman & Valenstein 1972

Husain & Kennard 1996

- **Thalamus**
  - Watson & Heilman 1979
  - Watson et al. 1981
- **Basal ganglia**
  - Damasio et al. 1980
  - Healton et al. 1982
  - Hier et al. 1977
- **Internal capsula**
  - Ferro & Kertesz 1984
- **Territory of a. choroidalis ant**
  - Masson et al. 1983
  - Bogousslavsky et al. 1988
  - De la Sayette et al. 1995

Lesions associated with chronic neglect

Key role of the temporal convexity: below
Additional evidence for the role of frontal convexity and basal ganglia (Maguire & Ogden 2002; Farne et al. 2004)



Karnath et al. 2011; Karnath and Rorden 2012

Hemineglect = a modular deficit

Dissociation between sensory modalities

Double dissociations within visuo-spatial neglect

Near vs far space

- Cowey et al. 1994
- Beschin & Robertson 1997
- Guariglia & Antonucci 1992

Perception vs visual imagery

- Anderson 1993
- Coslett 1997
- Guariglio et al. 1993

Global vs local aspects

- Marshall & Halligan 1995

Viewer-centred vs stimulus-centred

- Hillis & Caramazza 1995
- Ota et al. 2001
- Hillis et al. 2005
- March & Hillis 2007

Two types of auditory neglect

Attentional bias

Attentional deficit for left hemispace

Without deficits in sound localisation

Lesions centred on basal ganglia

Distortion of auditory spatial representation

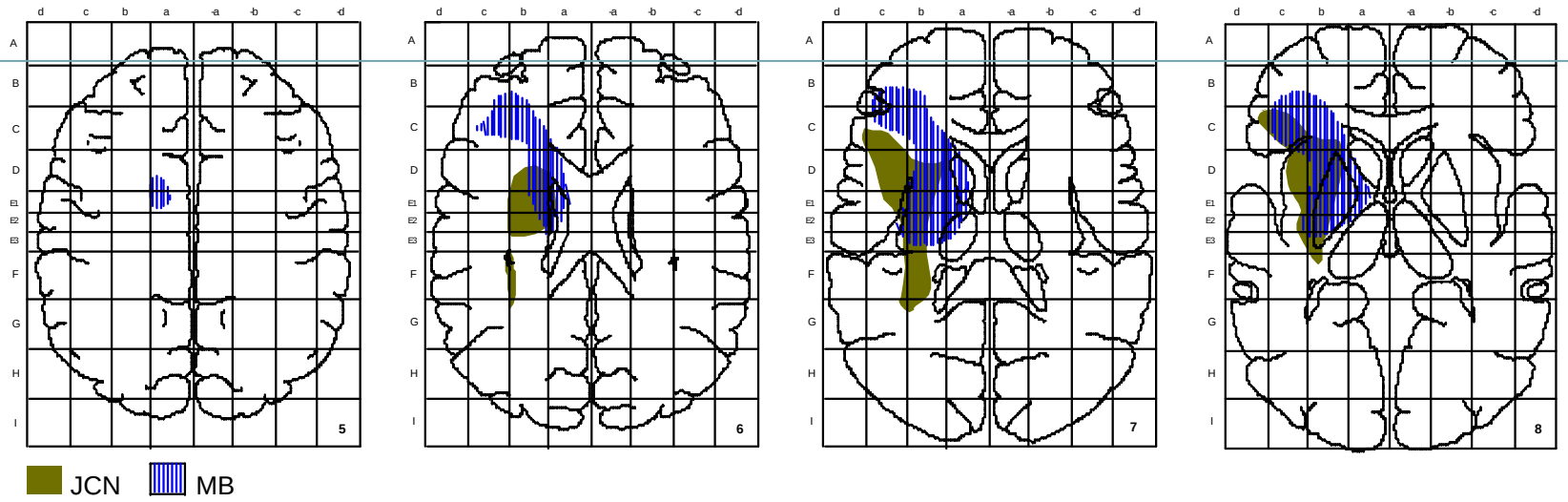
- Alloacusis, ipsilesional biais in auditory localisation
- No attentional differences between left and right hemispace
- Parieto-frontal lesions

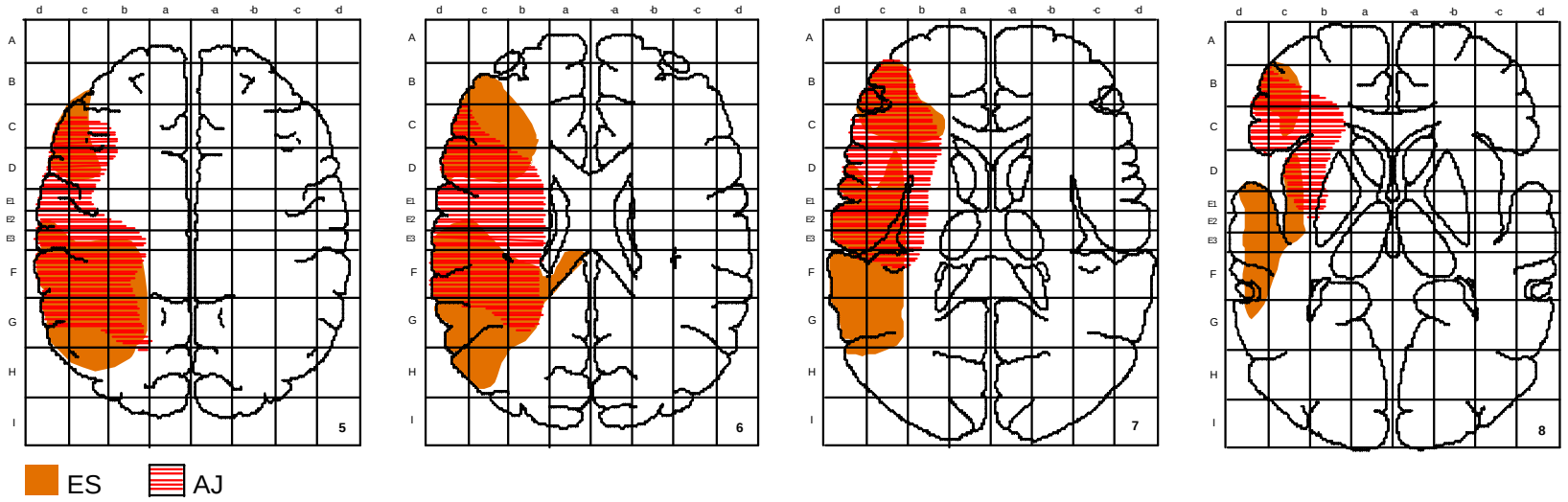
What **Where**

Bellmann, Meuli, Clarke, Brain 2001
Clarke et al. , Cortex 2004
Spierer et al. , Neuropsychologia 2007

Two types of auditory neglect: anatomo-clinical correlations

Attentional bias vs distortion of auditory-spatial representation





Bellmann, Meuli, Clarke, *Brain* 2001

canton de vaud

UNIL | Université de Lausanne

CHUV

Rehabilitation interventions for neglect

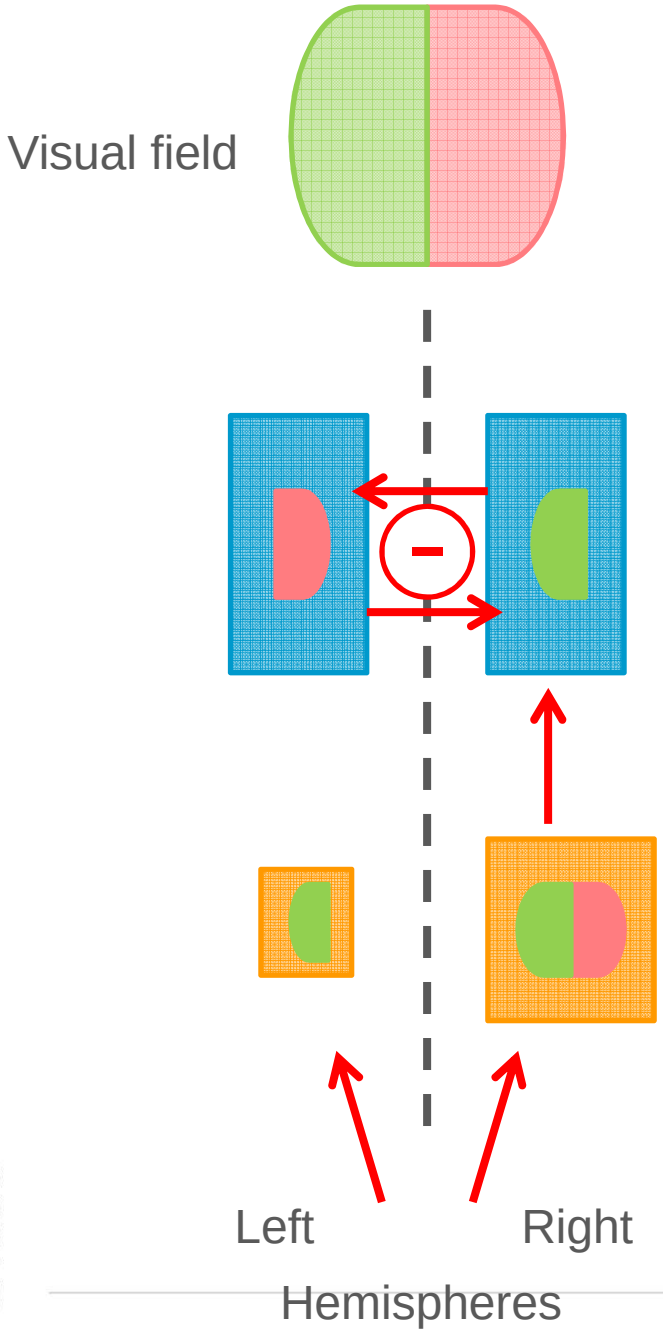
- **Attend to the left**
  - Visual scanning training
  - Visuo-spatio-motor cueing
  - Kinetic stimuli
  - Video training
  - Forced use of left visual hemifield or left eye
- **TMS or tDCS to left hemisphere**
- **Training of sustained attention, alertness**
- **Multisensory representations**
  - Vestibular stimulation (caloric or galvanic)
  - Vibration stimulation of neck muscles
  - Transcutaneous electrical stimulation of neck muscles
  - Trunc orientation
  - Prism adaptation
- **Medication**

Clarke and Bindschaedler 2014

Cognitive and neurobiological models which will be discussed

- Dorsal and ventral attentional networks
- Different role of each hemisphere for spatial attention
- Role of arousal and phasic attention
- Breakdown of interhemispheric inhibition
- Hyperexcitability of the intact, left hemisphere
- Disturbance of multisensory representations

Cognitive models of neglect



Dorsal attentional network

Voluntary orienting of attention

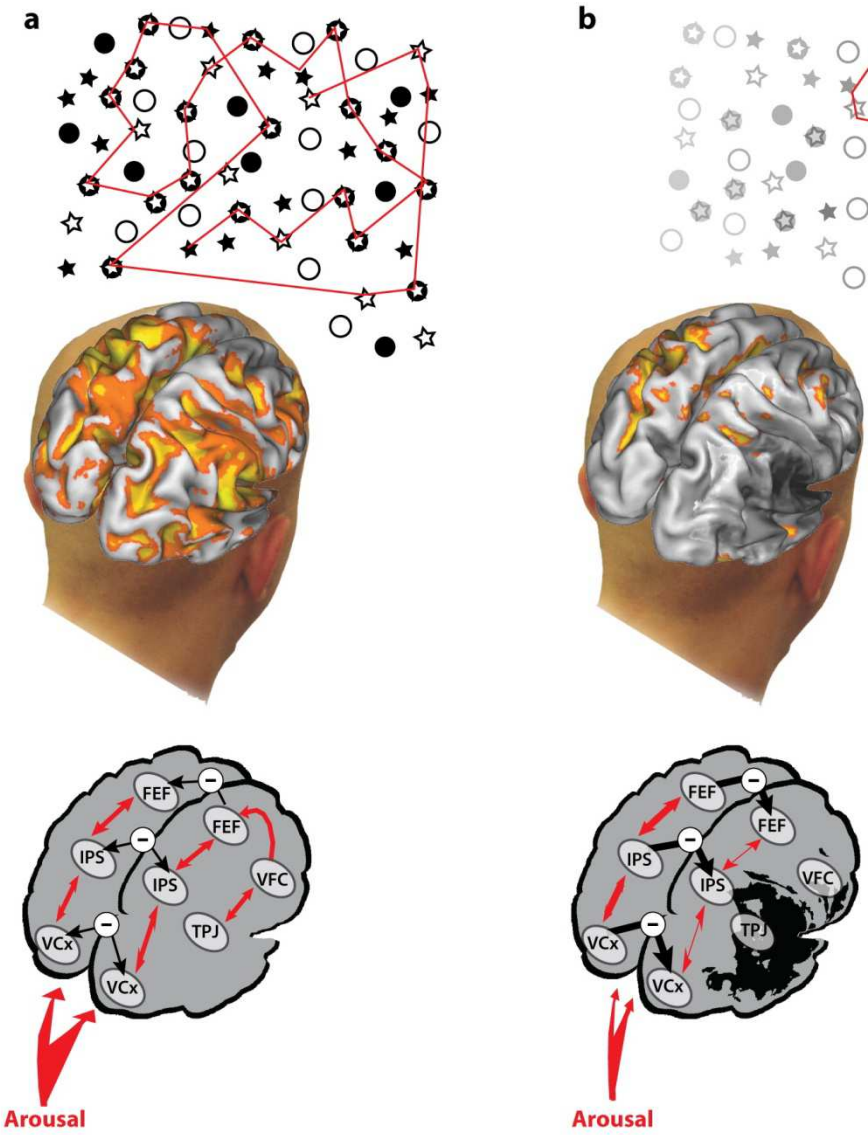
superior parietal lobule & intraparietal sulcus

Ventral attentional network

reorienting to behaviourally relevant targets

Inf. parietal lobule & superior temporal gyrus (temporoparietal junction)

Effects of damage to ventral attentional network



(*a*) healthy brain,
visual search is symmetric
interhemispheric interactions between left and right dorsal attention and visual occipital areas = balanced.
shifts of attention and eye movements contralaterally

(*b*) patient with a ventral stroke with direct damage to ventral regions
reduction of arousal, target detection, and reorienting = a bilateral visual field impairment
abnormal ventral-to-dorsal interactions = an interhemispheric imbalance in the dorsal attention network and visual cortex
= leading to tonic and task-dependent rightward spatial biases in attention, eye movements, and stimulus salience.

Corbetta and Shulman 2011

Corbetta M, Shulman GL. 2011.
Annu. Rev. Neurosci. 34:569–99

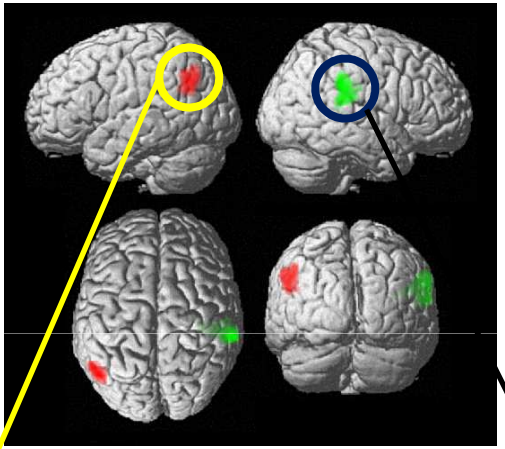
canton de vaud

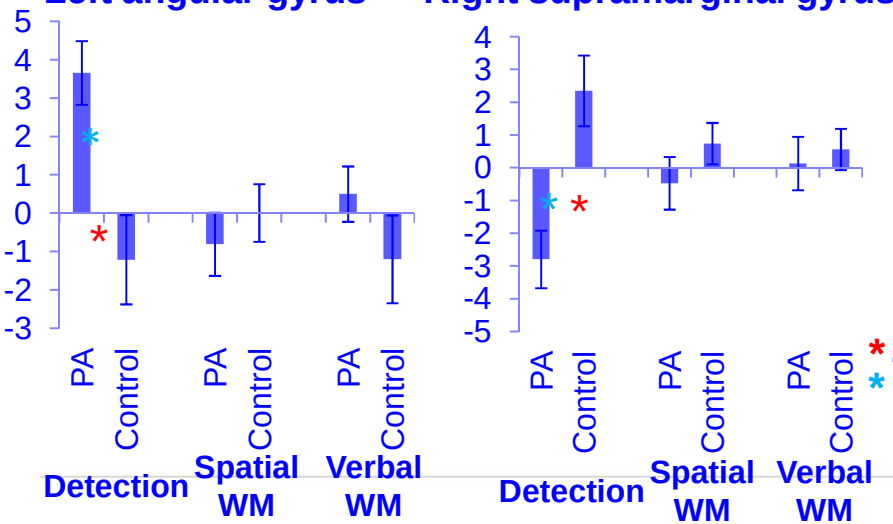
UNIL | Université de Lausanne

In normal subjects a single, brief PA session enhances the representation of the left visual space within the left inferior parietal cortex.

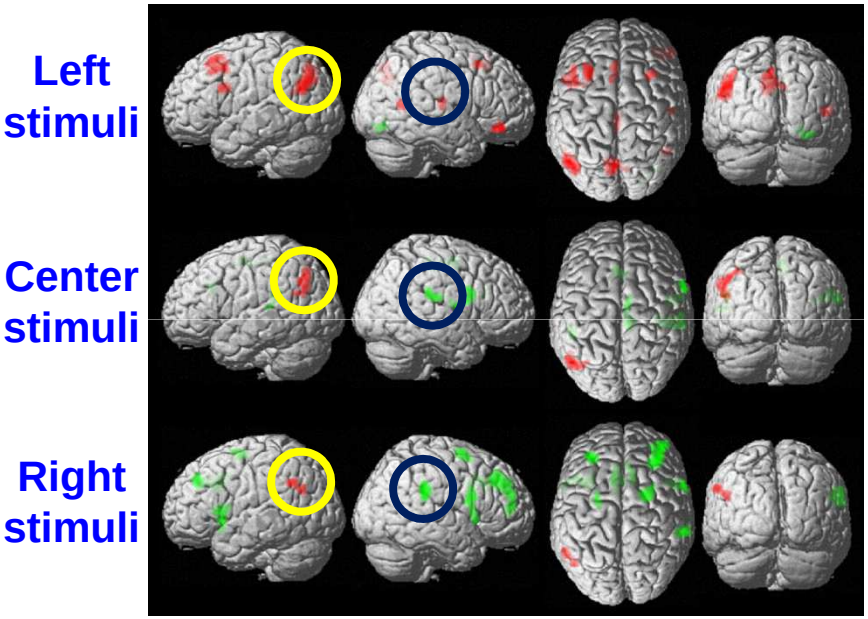
Changes during detection & WM tasks: after vs before a brief PA exposure

ANOVA 2 (PA, ctrl) x 3 (tasks)





Post hoc PA vs ctrl, detection task

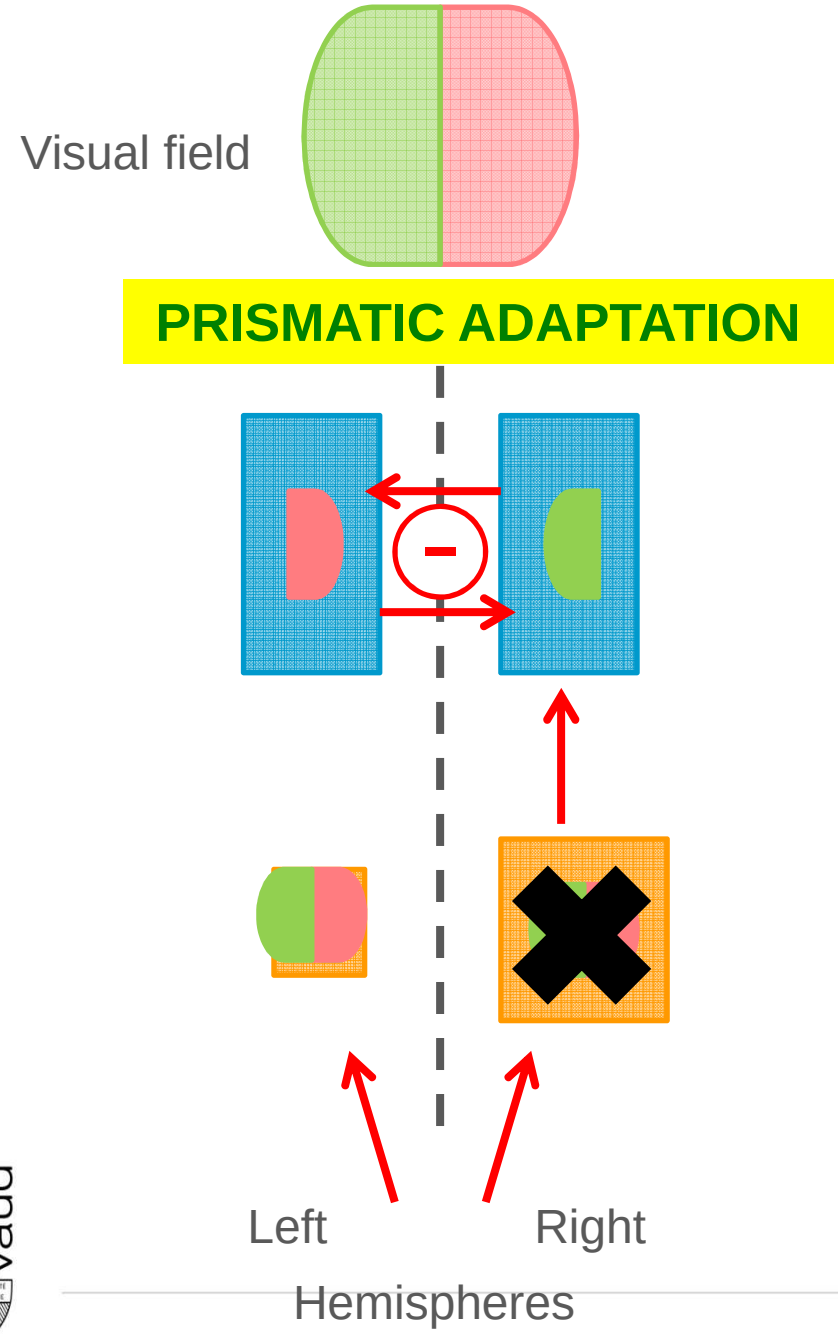


Red: PA group > Control group
Green: PA group < Control group

* 2 conditions significantively different
* 1 condition significantively ≠ 0

Crottaz-Herbette, Fornari & Clarke 2014

Cognitive models of neglect



Dorsal attentional network

Voluntary orienting of attention

superior parietal lobule & intraparietal sulcus

Ventral attentional network

reorienting to behaviourally relevant targets

Inf. parietal lobule & superior temporal gyrus (temporoparietal junction)

Effectiveness of theurapeutic interventions in neglect: meta-analyses

Cognitive rehabilitation for spatial neglect following stroke
Bowen, Hazelton, Pollock, Lincoln
Cochrane collaboration, 2013

Fasotti and van Kessel 2013
Novel insights in the rehabilitation of neglect

Müri et al 2013
Non-invasive brain stimulation in neglect rehabilitation: an update

Effectiveness of theurapeutic interventions in neglect

Cognitive rehabilitation for spatial neglect following stroke
Bowen, Hazelton, Pollock, Lincoln
Cochrane collaboration, 2013

Authors' conclusions:

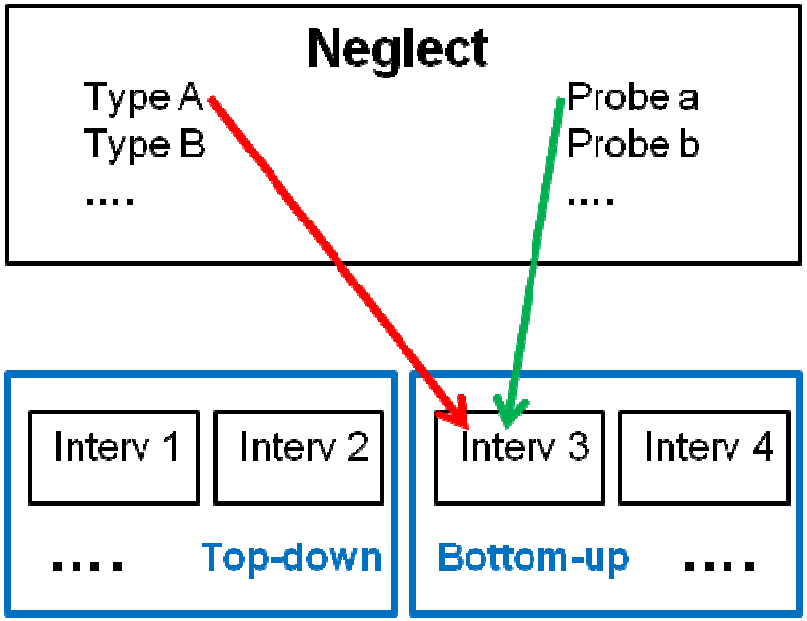
- **Effectiveness of cognitive rehabilitation interventions for reducing the disabling effects of neglect and increasing independence remains unproven.**
- **No rehabilitation approach can be suppported or refuted based on current evidence**
- **Limited evidence for immediate effect of cognitive rehabilitation on tests of neglect.**
- **Necessity for high quality methodological design and reporting of future studies**
- **Patients with neglect should continue to receive general stroke rehabilitation and to have opportunity to participate in high quality studies.**

To increase the impact of rehabilitation interventions it is necessary to refine the indications for therapeutic interventions in neglect

For detailled discussion: Clarke, Bindschaedler, Crottaz-Herbette 2015 *Stroke*

Not all patients respond equally well to one or other therapeutic intervention.

- **To identify correctly indications for specific approaches**
- **Who are the responders to a specific intervention?**
- **To understand the mechanisms underlying the effects of the intervention**



To design studies with therapeutic interventions which take into account the type of neglect

- **To enroll only a specific type of neglect (A, B, ..) in a trial with a given intervention**
- **To use a probe to identify good responders**

Conclusions

- **Need for large-scale randomized controlled trials, which take into account long-term outcome in terms of activities of daily living and of social and professional integration**
- **Need for better integration of cognitive models: design of interventions, indications, design of studies**
- **Need to refine indications for specific therapeutic interventions by identifying responder profiles.**

9TH WORLD CONGRESS FOR
NEUROREHABILITATION

10-13 May, Philadelphia 2016

SAVE THE DATE

FROM SCIENCE **TO SOCIETY**

WFNR
World Federation for NeuroRehabilitation

ASNR AMERICAN SOCIETY OF NEUROREHABILITATION

www.wcnr2016.org