IDENTIFYING PATHWAYS TO BLINDSIGHT IN HEMISPHERECTOMIZED SUBJECTS USING DTI TRACTOGRAPHY

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INTRODUCTION

Blindsight

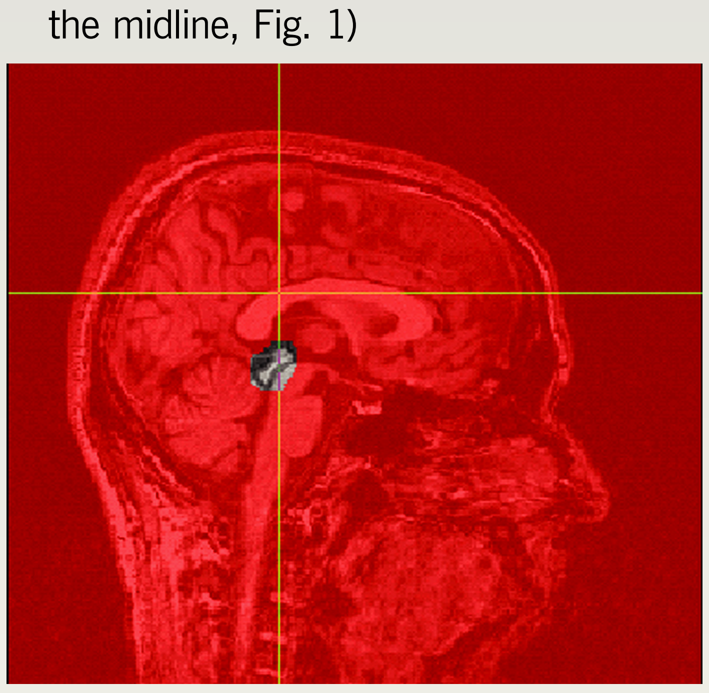
- Ability of cortically blind patients to respond to visual stimuli in the blind field without awareness
- Its existence has been questioned due to artifacts, particularly that remnants of functional striate cortex are responsible
- We eliminated this option by testing hemispherectomized subjects (Hs) who showed 'attention-blindsight' ('Type I'-blindsight) in a previous behavioural study (Ref. 1)
- We reconstructed superior colliculus (SC) tracts in 6 normal subjects as well as 2 Hs with and 2 without blindsight.

DATA ACQUISITION

- 1.5 Tesla MRI Sonata scanner (Siemens) using echo-planar imaging
- Parameters for diffusion weighted data: Repetition time: 9300 ms; echo time: 94 ms; flip angle: 90°; slice thickness = 2.2 mm; number of Slices: 60; in-plane resolution: 2.1875 mm x 2.1875 mm; acquisition time approximately 9:30 minutes. Diffusion weighting was performed along 60 independent directions with a b-value of 1000 s/mm^2. A reference image with no diffusion weighting was also obtained.

IMAGE PROCESSING

- Raw DTI data was corrected for motion and eddy currents
- Probability distribution function was estimated on the principal fiber direction at each voxel using Bayesian Techniques (Ref. 2, 3)
- Probabilistic fiber tracking was initiated from seed masks of the right and left SC
- Analysis was restricted to fibers crossing at the level of the SC by using an exclusion mask (saggital slice along the midline, Fig. 1)

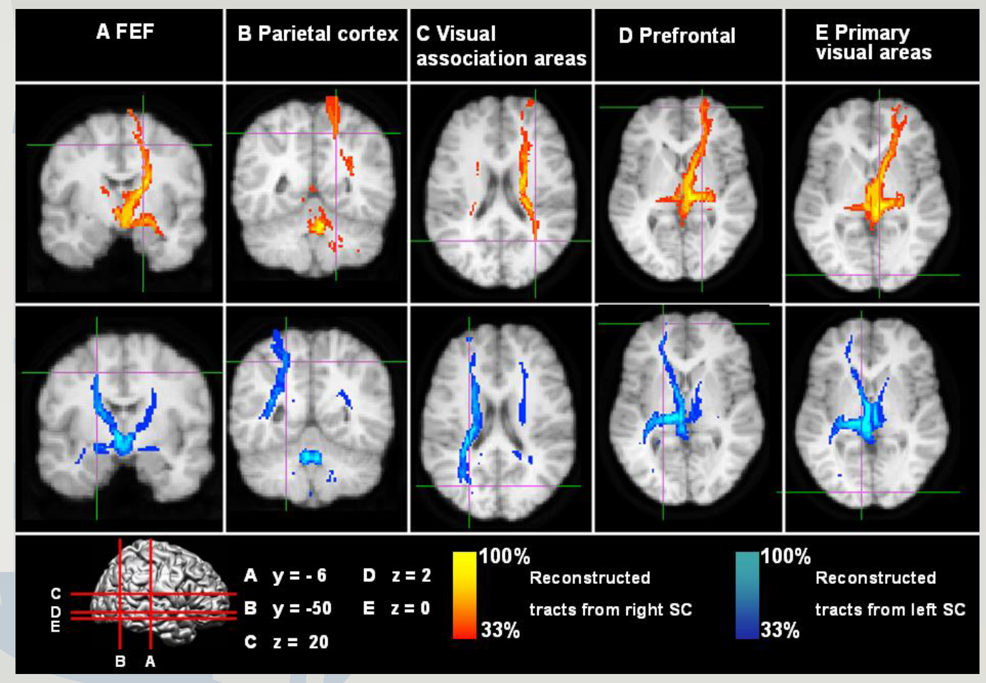


- All tracts were registered to MNI standard stereotaxic space
- Tracts of healthy subjects were thresholded, binarized and summed across subjects
- A population map was then obtained presenting only tracts that were present in at least 33% of the normal subjects (Fig. 2)

RESULTS

Healthy subjects (Fig. 2)

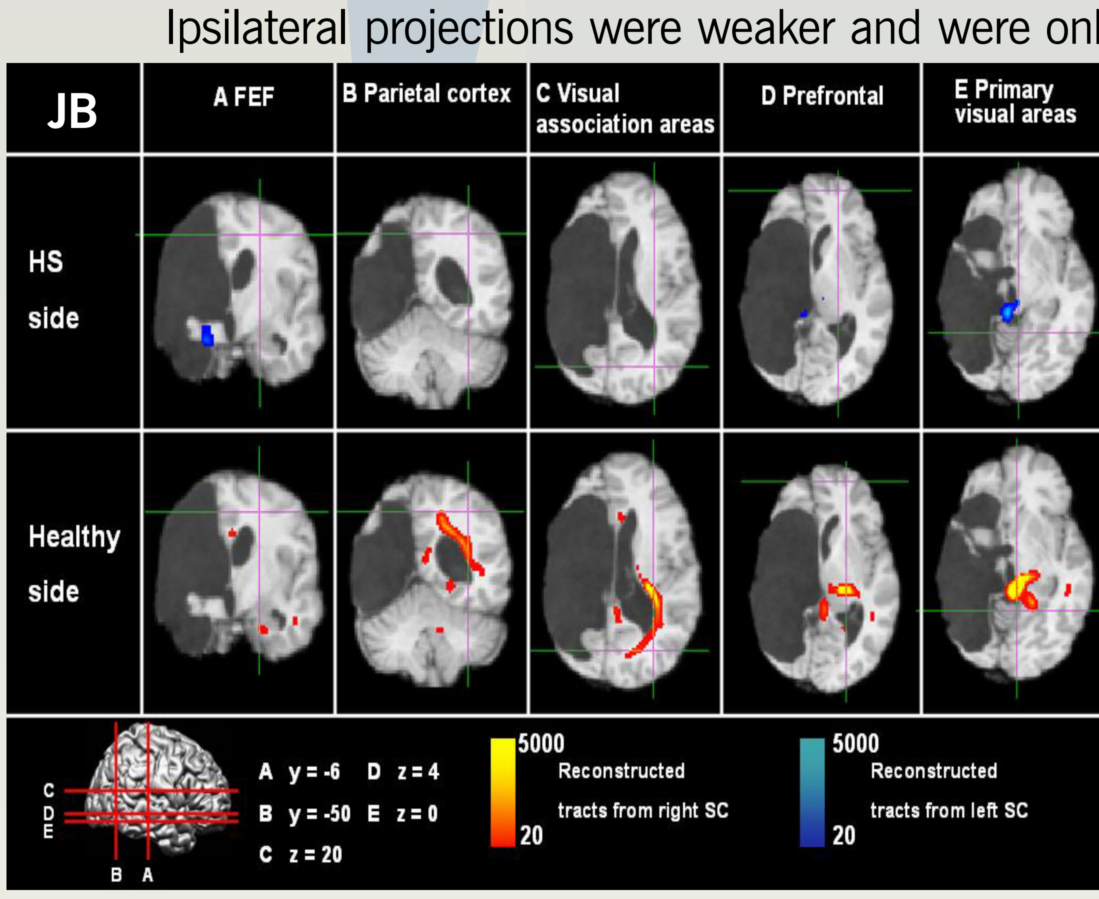
Ipsilateral connections to *visual association areas* (x = ±28, y = -74, z = 20), *parietal-occipital cortex* (x = ±32, y = -50, z = 50), *prefrontal areas* (x = ±20, y = 62, z = 2), and close to an *area* (right SC: x = 18, y = -6, z = 50; left SC: x =-20, y =-6, z = 46) that has previously been described as *frontal eye fields* (FEF; Paus, 1996; x = ±24, y = 6 to 1, z = 44 to 51), but not to *primary visual areas*.

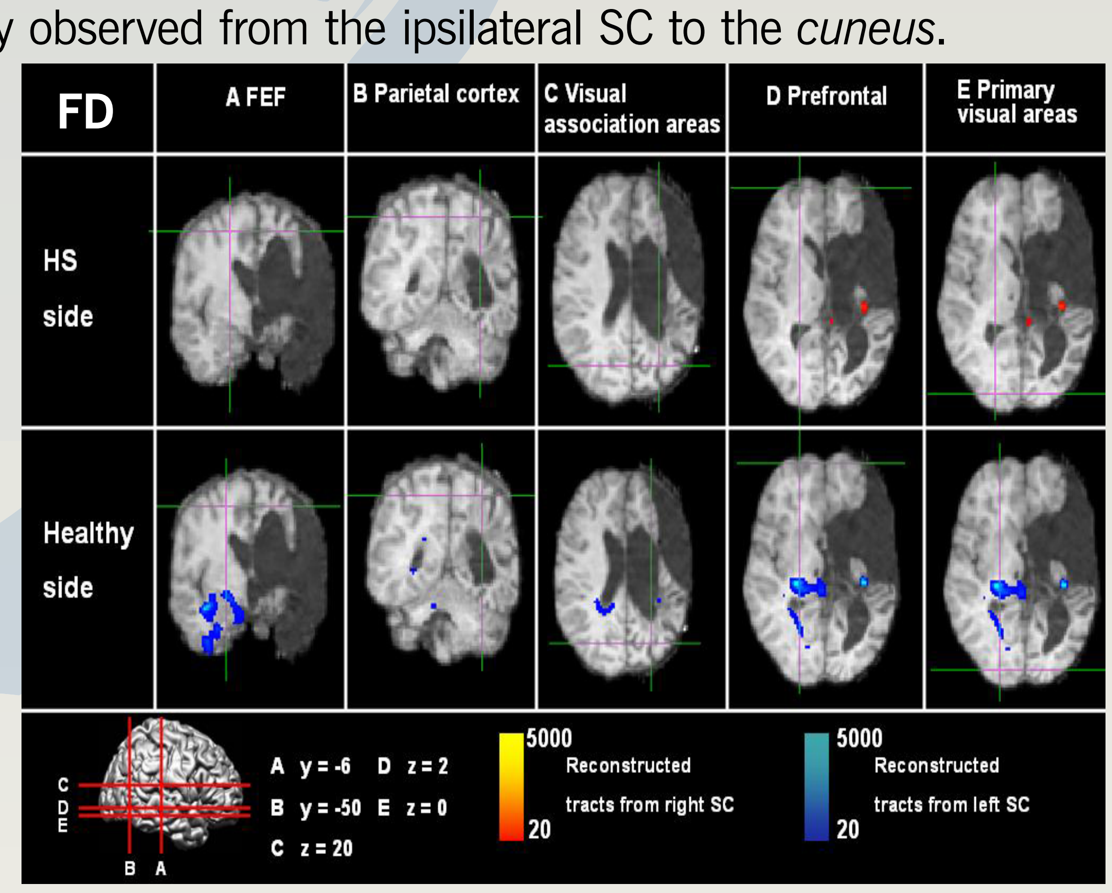


Hs without blindsight: JB (Fig. 3) and **FD (Fig. 4)**

Absence of connections from the hemispherectomized SC to the contralateral hemisphere.

Ipsilateral projections were weaker and were only observed from the ipsilateral SC to the *cuneus*.





Hs with blindsight: SE (Fig. 5) and **DR (Fig. 6)**

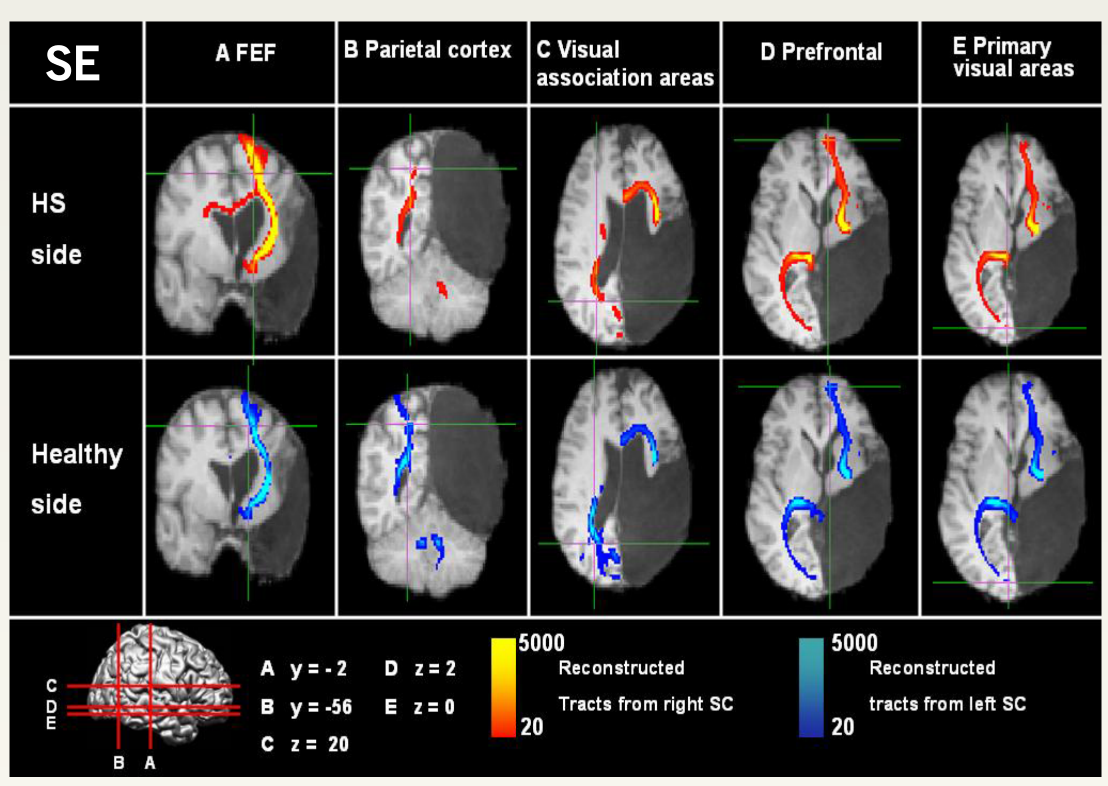
Strong contralateral and ipsilateral projections from the SC to the remaining hemisphere.

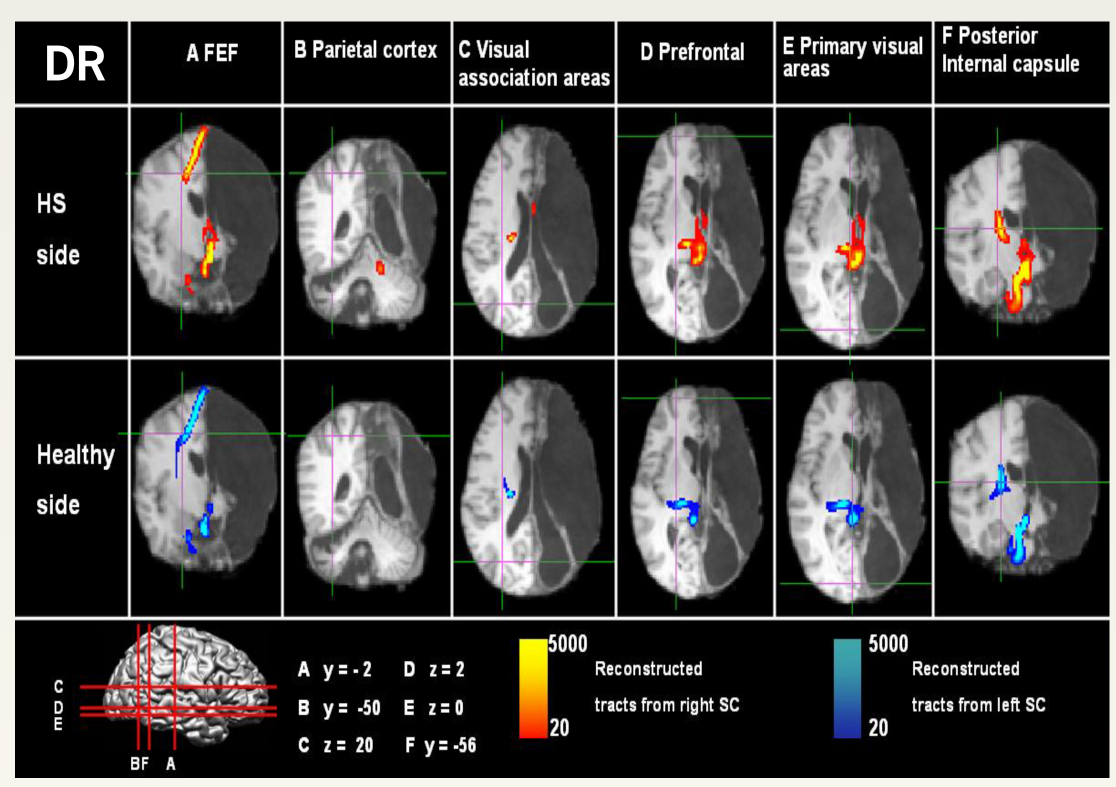
Subject SE:

Connections to an area close to the *FEF* (x=18, y=-2, z=50), *parieto-occipital areas* (x=-20, y=-56, z=48), to *visual association areas* (x=-28, y=-74, z=20; x=-4, y=-90, z=-22) and to *primary visual areas* (x=-2, y=-90, z=0).

Subject DR:

Connections to *posterior internal capsule* (x=-20, y=-20, z=12) and to areas close to the *FEF* (x=-20, y=-10, z=44).





CONCLUSIONS

- We were able to demonstrate the existence of strong ipsilateral and contralateral projections from the SC to primary visual areas, visual association areas, precentral areas/FEF and the internal capsule of the remaining hemisphere only in those hemispherectomized subjects **with** 'Type I'- or 'attention-blindsight'.
- No such connections could be identified in those hemispherectomized subjects **without** 'Type I'- or 'attention-blindsight'.
- A control tract was chosen to validate DTI data quality and analysis methods: All participating subjects showed similar tracings of the corticospinal tracts (results not shown, for further details see Ref. 4).
- These results strongly support an essential role of the SC in blindsight.
- This study also demonstrates the usefulness of DTI tractography in investigating cerebral plasticity, compensation and reorganization following various cerebral lesions.

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