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BLINDSIGHT AND THE PROCESSING OF COMPLEX STIMULI: A BEHAVIOURAL AND AN fMRI STUDY OF A HEMISPHERECTOMIZED PATIENT

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Introduction

Our goal is to identify areas in the brain associated with residual vision and perception of emotional facial expressions in the blind field of hemianopic subjects. Hemispherectomized subjects represent a good model for studying residual visual abilities in the blind field because one cerebral hemisphere, including the occipital lobe, has been removed or disconnected leaving the patient with a contralateral hemianopia without macular sparing. Destruction of the occipital lobe had been thought to lead to permanent blindness in the contra-lateral visual field. However, the ability to respond to visual stimuli in the blind field without consciously experiencing them, known as blindsight, has been reported (e.g. Weiskrantz et al., 1974). The neuronal correlates of blindsight especially following hemispherectomy remain unclear.

Methods

Subject:

DR is a 29 year-old, right-handed woman with a contralateral homonymous hemianopia who underwent a right functional hemispherectomy, including amygdala and hippocampus, at age 17 for the treatment of Rasmussen's chronic encephalitis. The surgery was performed at the Montreal Neurological Institute & Hospital. Her intellectual level was estimated in 1992 using the Wechsler Adult Intelligence Scale-Revised (WAIS-R). She has a Full-Scale IQ rating in the Average range, with the Performance Scale, and the Verbal Scale in the same range (more details in Bittar et al., 1999).

Stimuli:

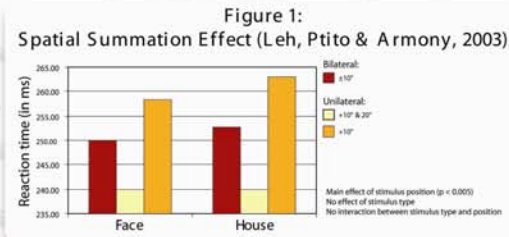
DR participated in three computer-based experiments, which we used in a previous study on healthy subjects. Stimuli were neutral and fearful faces from the Ekman set and pictures of houses. Stimuli were presented randomly at 10° right or left of a central fixation point, or bilaterally. The experiment consisted of a house detection task, a face detection task, and a fear-neutral face discrimination task using functional MRI (fMRI) to examine the associated cerebral activation patterns.

Neuroimaging methods

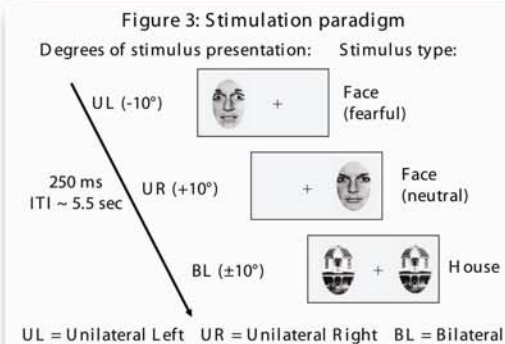
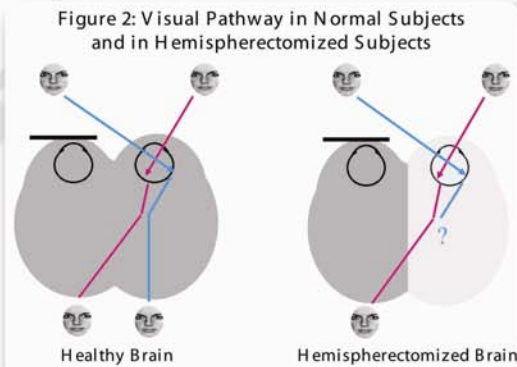
- m Data were acquired on a 1.5 Tesla MRI Sonata scanner (Siemens)
- m Blood oxygenation level dependent (BOLD) fMRI
- m T2*-weighted gradient echo EPI sequence (TR = 2540 ms, TE = 50 ms), 30 slices (4 mm thickness)
- m 2 scanning sessions
- m 3 functional scanning runs in the first session, and 6 in the second session
- m Images were realigned and corrected for motion using an intrarun realignment algorithm in SPM99

Results

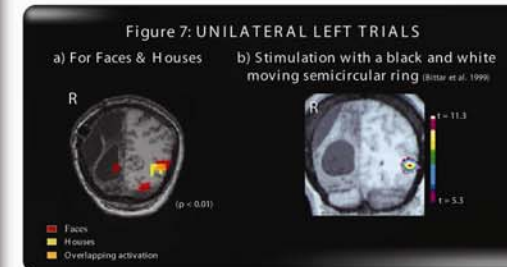
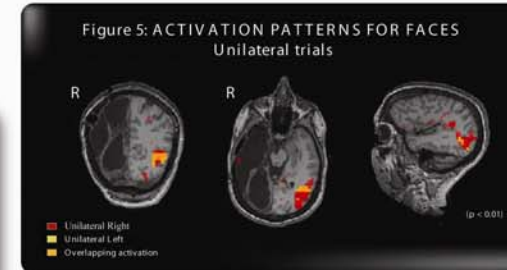
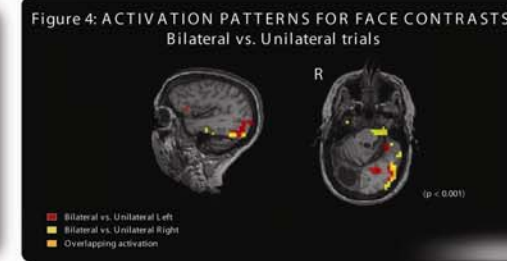
Previous behavioural results:



In a previous study (Leh, Ptito & Armony, 2003) DR showed a significant Spatial Summation Effect. She responded faster to two stimuli compared to a single one, even if the second stimulus was presented in her blind field, strongly supporting the existence of blindsight.



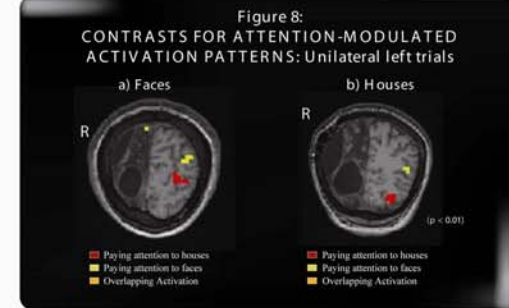
fMRI Session 1:



- m Unconsciously seen faces and houses activate ventral extrastriate visual areas in the ipsilateral hemisphere
- m But, houses seem to activate additional higher visual areas ipsilaterally
- m And, DR seems to show stronger activation for houses

IS THIS STRONGER ACTIVATION ATTENTION-MODULATED?

fMRI Session 2:



Conclusions

- m Extending previous fMRI studies (Bittar et al., 1999), we found an ipsilateral occipital activation when complex stimuli were presented in DR's blind visual field.
- m Because she has a documented hemianopia without macular sparing and the possibility of spared visual islands of the visual cortex is not tenable, these results lend further support to the existence of blindsight in this subject.
- m Interestingly, her ability to process houses and associated activation patterns appear to be stronger compared to faces.
- m These capacities seem to be attention-modulated:
- m The ventral extrastriate visual cortex seems to be activated in all conditions, but stronger for faces compared to houses.
- m In addition, higher primary visual areas seem to be activated as well by houses.

References

- (1) Weiskrantz, L., Warrington, E.K., Sanders, M.D., & Marshall, J. (1974). Visual capacity in the hemianopic field following a restricted occipital ablation. *Brain* 97(4), 709 - 28.
- (2) Bittar, R.G., Ptito, M., Faubert, J., Dumoulin, S.O., and Ptito, A. (1999). Activation of the remaining hemisphere following stimulation of the blind hemifield in hemispherectomized subjects. *NeuroImage*, 10, 3339-346.
- (3) Leh, S., Ptito, A. & Armony, J. (2003). Spatial Summation and perception of emotional faces in healthy and a hemispherectomized subject: A preliminary study. *Cognitive Neuroscience Society, Annual Meeting*, New York City, USA.

Acknowledgements

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