Cognitive neuropsychology in 2018.

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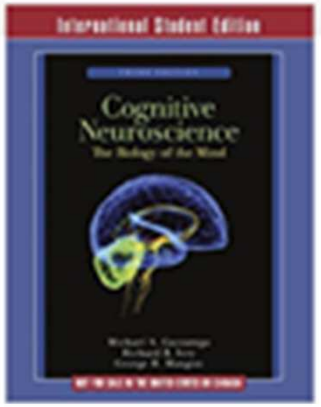
La Sapienza May 17th 2018

UNIVERSITY OF COPENHAGEN

1. Behrmann & Plaut framework
2. Plasticity and cognitive neuropsychology
3. Re-interpretation of Behrmann & Plaut
4. Debate: Is cognitive neuropsychology relevant in 2018?

Pure alexia and prosopagnosia

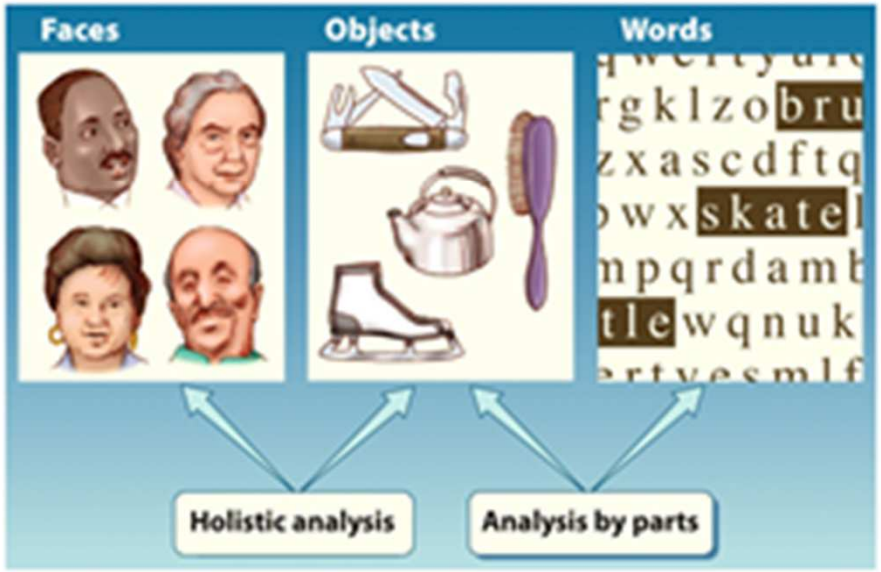


Textbook knowledge (Gazzaniga, 2014):

Face and word (and object?) processing are dissociated / dissociable cognitive and cerebral processes.

Table 6.2 Patterns of Co-occurrence of Prosopagnosia, Visual Agnosia, and Alexia

Pattern	Number of Patients
Deficits in all three	21
Selective deficits	
Face and objects	14
Words and objects	15
Faces and words	1 (possibly)
Faces alone	35
Words alone	Many described in literature
Objects only	1 (possibly)



Behrmann & Plaut, Cerebral cortex, 2014

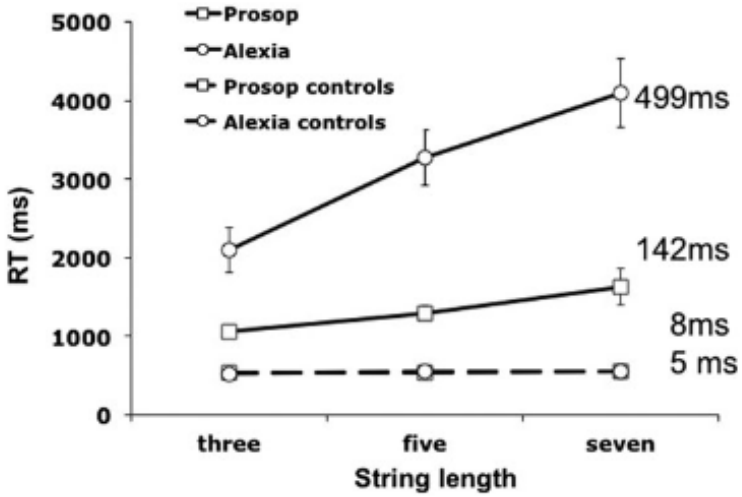
Bilateral Hemispheric Processing of Words and Faces: Evidence from Word Impairments in Prosopagnosia and Face Impairments in Pure Alexia

Marlene Behrmann and David C. Plaut

Table 2
Single case summary statistics (patient vs. matched controls)

Experiments	Pure alexia				Prosopagnosia		
	DK[a]	EL	FF	SH[a]	SM	RN	CR
Word reading (RT slope)	**	**	**	**	*	**	**
Lexical decision (RT slope words)	**	**	**	*	**	**	*
Face discrimination (error in "easy" condition)	ns	*	*	ns	**	*	**
Face discrimination (error in "medium" condition)	*	*	**	**	**	**	**
Face orientation (Inverted RT–upright RT difference)	*	**	**	**	**	**	*
Face rotation (accuracy in profile view)	*	**	**	*	**	**	**

Note: [a]Hemianopia.
*$P \leq 0.05$.
**$P < 0.01$.



Behrmann & Plaut, Cerebral cortex, 2014

Conclusion

Conventional wisdom holds that faces and words are independent domains of high-level vision subserved by independent neural mechanisms located in opposite hemispheres. On this view, lesions to the right hemisphere that impair face recognition (in prosopagnosia) should leave word recognition unaffected, and lesions to the left hemisphere that impair word recognition (in pure alexia) should leave face recognition unaffected. The current work shows that neither of these predictions is upheld. Instead, prosopagnosics have mild but reliable word recognition deficits, and pure alexics have mild but reliable face recognition deficits. The apparent co-mingling

Roberts et al., Cortex, 2015

Processing deficits for familiar and novel faces in patients with left posterior fusiform lesions

Daniel J. Roberts [a], *Matthew A. Lambon Ralph* [b], *Esther Kim* [c], *Marie-Josephe Tainturier* [d], *Pelagie M. Beeson* [e], *Steven Z. Rapcsak* [f,g] *and Anna M. Woollams* [b,*]

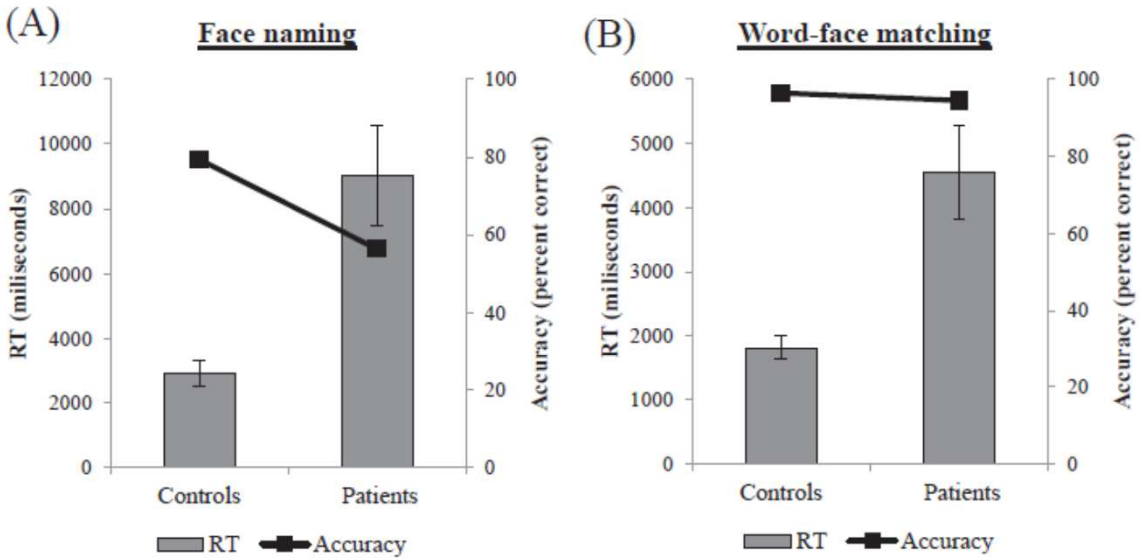


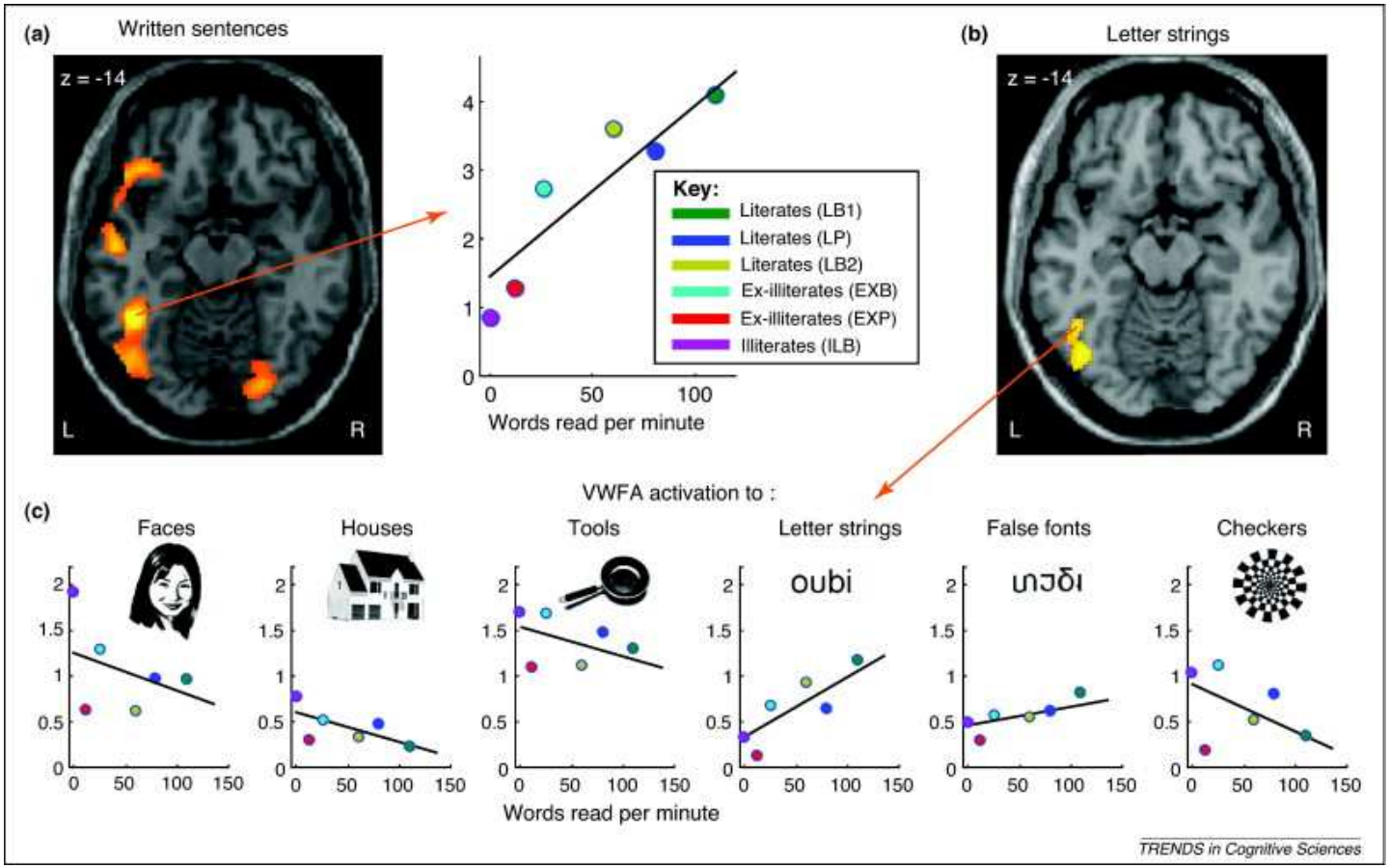
Fig. 4 – Means reaction times and accuracy for nine patients and nine matched controls for the famous face (A) naming (patient accuracy range = 15–93%) and (B) matching (patient accuracy range = 63–100%). Error bars indicate ± standard error.

Roberts et al., Cortex, 2015

Conclusion

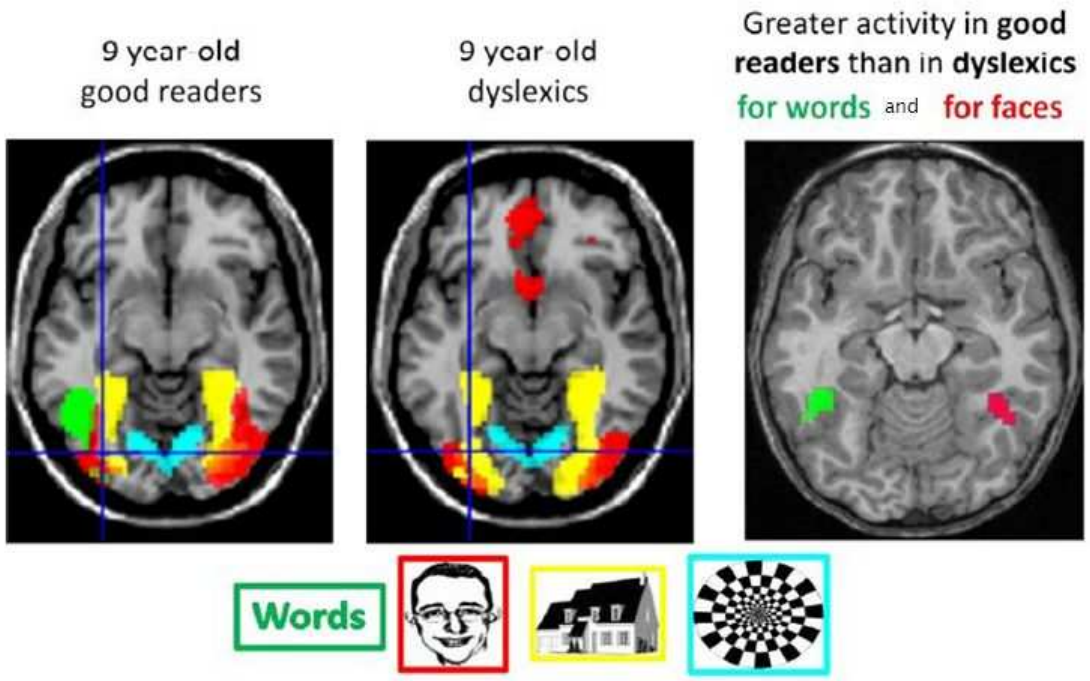
spacing and frontal activation for faces varying only on features. These results suggest that the sequential part-based processing strategy that promotes the length effect in the reading of these patients also allows them to discriminate between faces on the basis of feature identity, but processing of second-order configural information is most compromised due to their left pFG lesion. This study supports a view in which the left pFG is specialised for processing of high acuity foveal visual information that supports processing of both words and faces.

How learning to read changes the cortical networks for vision and language (?)



Deahene & Cohen, *TICS*, 2011

Differences in Orthographic Processing Between Normal & Dyslexic Readers



The many-to-many hypothesis (Behrmann & Plaut, 2014)

- Makes specific predictions about the occurrence of specific deficits for faces and words (they will not occur).

- We tested this in a group selected on the basis of lesion (posterior stroke) rather than symptoms (prosopagnosia or pure alexia)

Word and face recognition deficits following posterior stroke:

Is there a common network for the recognition of faces and words?

Christina D. Kühn[1]*, Johanne Asperud Thomsen[2]*, Tzvetelina S. Delfi[2], Helle K. Iversen[2], Christian Gerlach[1], Randi Starrfelt[3]

[1]Department of Psychology, University of Southern Denmark, Denmark
[2] Rigshospitalet, Copenhagen, Denmark
[3] Department of Psychology, Copenhagen University, Denmark
* Shared first authorship to the study

Introduction

Different, lateralized brain areas have been proposed to be devoted to the recognition of faces (right hemisphere) and words (left hemisphere). Recently, this view has been challenged: Rather than category specific areas for perceptual processing of words and faces, a common, bilateral network supporting the recognition of both has been suggested.

We examined patients with focal lesions in posterior cortical areas to investigate if deficits in recognition of words and faces systematically co-occur.

Participants

Patients

Seven patients with MR-verified unilateral brain damage following stroke in the posterior cerebral artery were included. All patients were right-handed and tested > 1 year post stroke.

Patients	Gender	Age	Educational level	Etiology	Site of lesion	Visual field defects
KH	M	66	5	Infarct	L	R. hemifield
KL	M	57	5	Infarct	L	R. hemifield
KN	F	54	4	Infarct	R	No defects
LM	M	68	4	Infarct	R	L. hemifield
LO	F	66	3	Infarct	R	No defects
PK	M	67	3	Infarct	R	Upper l. quadrant
SR	F	74	1	Haemorrhage	L	Scotoma

Controls

Controls were matched for age and education. One-tailed single case t-tests were used to test for deficits (Crawford and Howell, 1998).

References

Crawford, J. R., & Howell, D. C. (1998). *The Clinical Neuropsychologist, 12*(4), 482-486.

This project was supported by a grant from the Danish Research Council for Independent Research (DFF-11-115958)

Reading Test

A single word reading test (3, 5, and 7 letters) measured the patients' reading speed and word length effect. RTs were measured by voice key.

Table 1: Results from the *Reading Test*. RT (ms). Word length effect (ms/letter). *P < 0.05, **P < 0.01. *Error range based on a larger control sample. Error rate > 3 indicates a deficit.

	Right hemisphere damage				Left hemisphere damage			Controls (n=27)
Patients	KN	LM	LO	PK	KH	KL	SR	Mean (SD), *Range*
Total mean RT	573	647**	624*	984**	1132**	1761**	592	498 (57)
Word length effect	16	20	15	73**	188**	370**	16	14 (11)
Reading errors	2	0	3	4	1	0	0	*0-3**

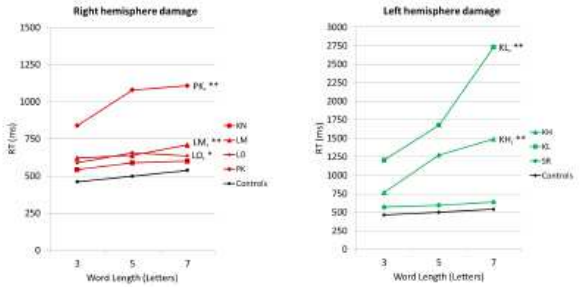


Figure 1: Mean RT (ms) for individual patients and the control group as a function of word length. * and ** for abnormal performance, see table 1.

Summary of Results

- Two right hemisphere patients showed deficits in all categories (words, faces, and objects).
- One patient with right and two patients with left hemisphere damage showed deficits for both words and faces but were unimpaired with objects.
- Two patients, one right and one left hemisphere damaged, showed a selective deficit for faces.

Delayed Matching Task

Word, face, and object recognition were examined using a delayed match-to-sample paradigm with four different stimulus categories: cropped faces, full faces, words, and cars.

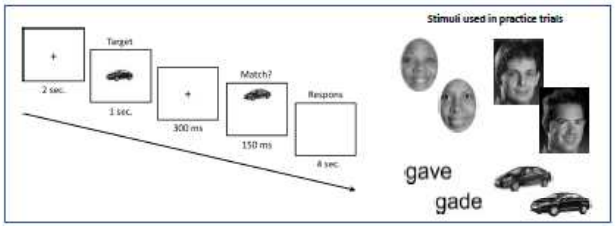


Table 2: Summary results from the four different categories in *Delayed Matching Task*. RT (ms). ACC (percentage correct responses). *P < 0.05, and **P < 0.01.

		Right hemisphere damage				Left hemisphere damage			Controls (N=25)
Patients		KN	LM	LO	PK	KH	KL	SR	Mean (SD)
Cars	ACC	77,5	66,3*	63,8*	78,8	73,8	85,0	78,8	80,1 (6,7)
	RT	755	1079*	1053*	930	941	972	743	813 (115)
Words	ACC	98,8	91,3*	95,0	85,0**	92,5	83,8**	96,3	96,9 (2,9)
	RT	794	969	988*	1081**	967	1296**	756	764 (124)
Cropped faces	ACC	80,0*	70,0**	76,3**	61,3**	82,5	70,0**	77,5**	89,8 (4,5)
	RT	624	1011*	864	835	915	946*	703	729 (115)
Full faces	ACC	96,3	68,8**	77,5**	66,3**	93,8	88,8	81,3**	94,4 (4,2)
	RT	605	984**	785	904*	896*	844	711	677 (99)

Conclusions

- This study supports the existence of a bilaterally distributed network for perceptual processing of faces and words.
- Selective deficits in face recognition suggest that parts of this bilateral network are specific for face processing.

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Acquired prosopagnosia without word recognition deficits

Tirta Susilo[a,b*], Victoria Wright[c], Jeremy J. Tree[d] and Bradley Duchaine[b]

Cog. Neuropsychology, 2015

Word and Text Processing in Acquired Prosopagnosia

Charlotte S. Hills, BSc,[1] Raika Pancaroglu, PhD,[1] Brad Duchaine, PhD,[2] and Jason J. S. Barton, MD, PhD, FRCPC[1]

Annals Neurol., 2015

But Fischer Baum & Campana suggests a different explanation

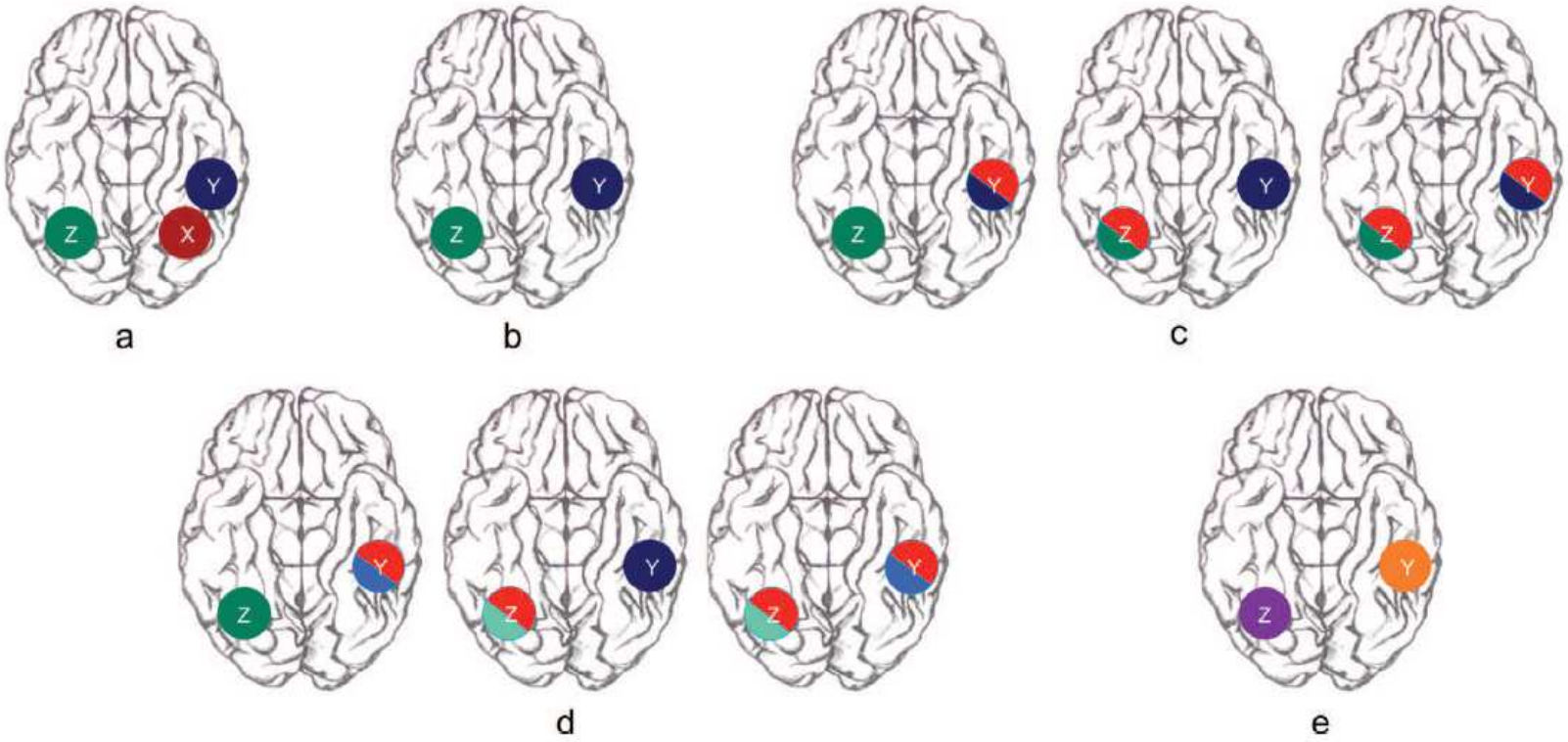
An alternative interpretation of this pattern is that in the undamaged brain there is functional and anatomical modularity, with the left occipitotemporal lobe subserving a reading function and the right occipitotemporal lobe subserving a face recognition function. However, if either region is damaged, there is *zero-sum functional takeover*, meaning that with a left occipitotemporal lobe lesion, the reading function is somewhat preserved at the slight expense of face processing, and the opposite pattern is observed with a right occipitotemporal lobe lesion. Perhaps

Neuroplasticity and the logic of cognitive neuropsychology

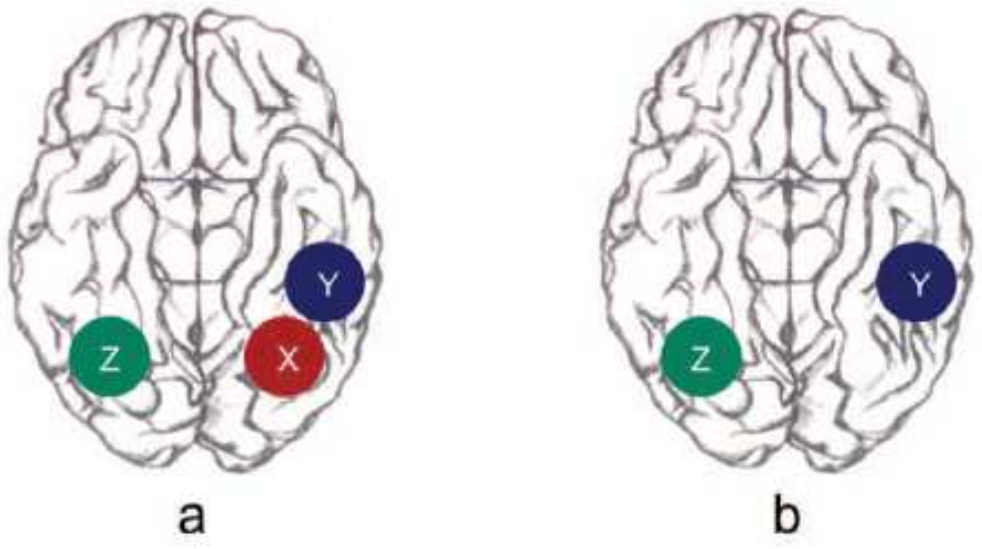
- Plasticity may have implications for the logic of cognitive neuropsychology; if new brain areas may take over functions or brain processes rearrange or compensate for deficits / injury, then we may not draw conclusions about the normal system based on (single case) studies of patients.

- When a piece of cortex is permanently damaged, what happens to the function normally subserved by this region?

The different possibilites

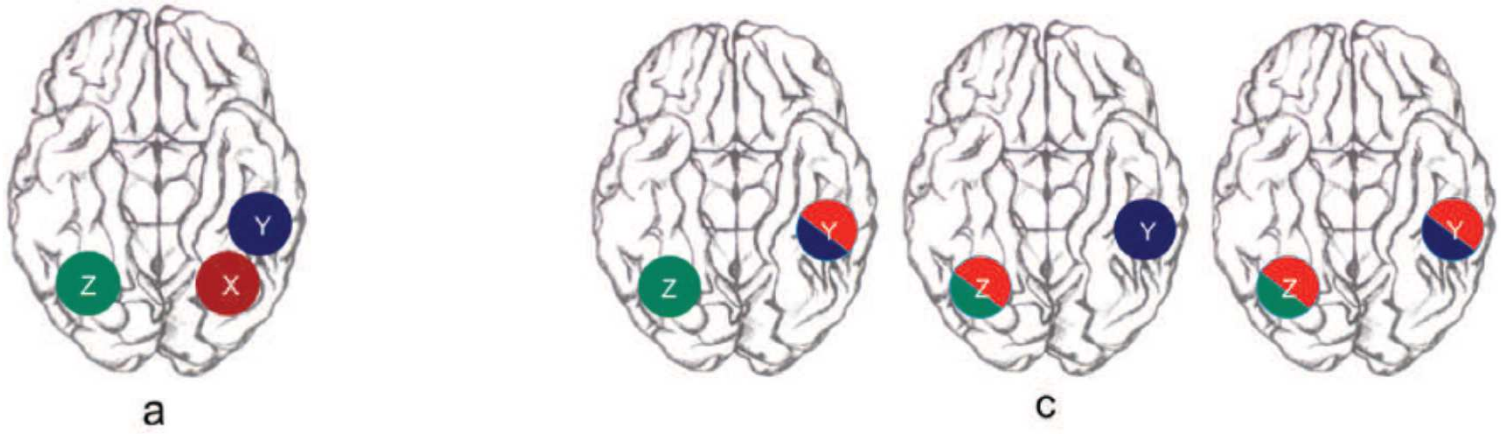


Simple subtraction



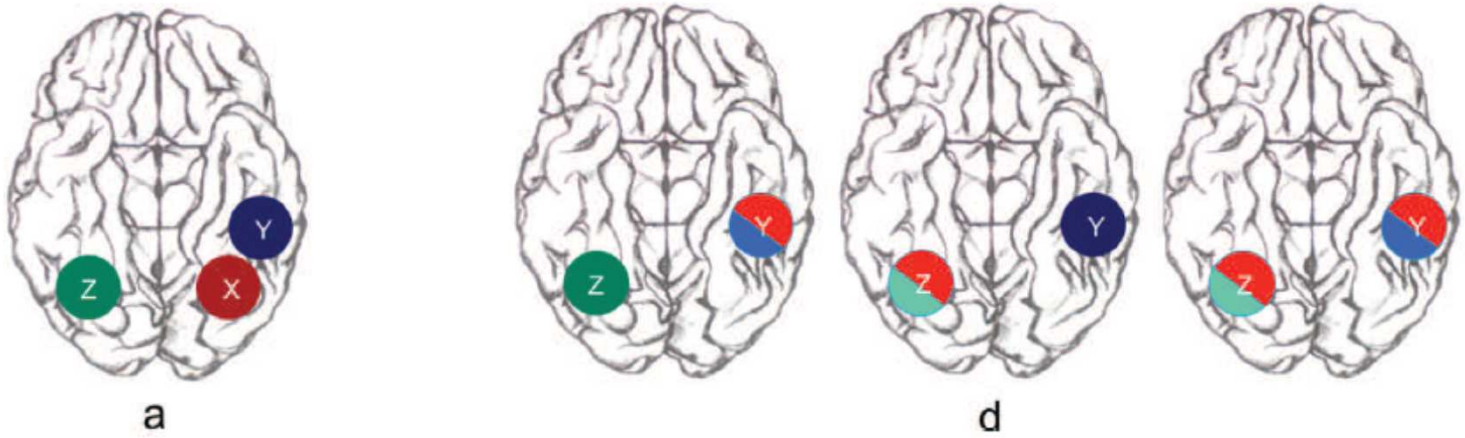
- When an area is damaged, the function subserved is lost. Other functions are not affected.

2. No cost functional takeover



- When an area is damaged, the brain is reaorganized so that the damaged fucntion becomes subserved by different regions (close to injury or homologous in other hemisphere).
- This has no impact on the previous function of these areas, i.e., no cost to other functions and damaged function also returns to normal level.

3. Zero sum functional takeover



- Damaged area affects function X: This function is taken over by homologue or perilesional area, but at a cost for the functions originally subserved by these areas

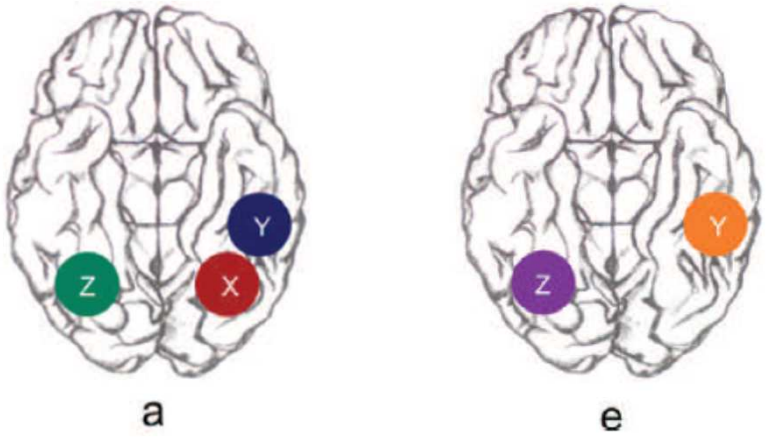
3. Zero sum functional takeover – a different interpretation of Behrmann & Plaut

- Word reading is subserved by VWFA (damage leads to pure alexia)
- Face processing is subserved by FFA (damage leads to prosopagnosia

- When damaged, the homologues area takes over some of the damaged function, but at a cost:

- The pure alexics when recovering will have subtle deficits in face processing (because FFA is now also used for reading)
- The prosopganosics when recovering will have subte deficits in reading (because VWFA is now also used for face processing)

5. Creation of a new kind of function



- Function normally subserved by X is lost.
- Regions Y and/or Z start processing information in a way different from wht X,Y,Z does in intact brain.

- This violates the subtractivity assumption, and conclusions about functional architecture cannot be drawn on the basis of cognitive neuropsychological studies.

Debate: Is cognitive neuropsychology still relelvant / important?

- Task for today: Prepare at least one argument for or against, and prepare to enter discussion about why / why not.

Debate: Is cognitive neuropsychology still important?

Go in groups: Select a "debate team" - the whole group agrees on arguments to present.

- Group 1: Cognitive neuropsychology is still important (more so than functional imaging of cognition).
- Group 2: Cognitive neuropsychology may still contribute in testing of theories of brain-behavior relationship, but functional imaging is more important and can test more complex theories.
- Group 3: Cognitive neuropsychology is a thing of the past: Group studies of patients and normals with high resolution imaging and functional imaging will provide the answers.

- Assignments if class not attended.

Summing up