Case studies and case series: Examples from the study of developmental prosopagnosia.

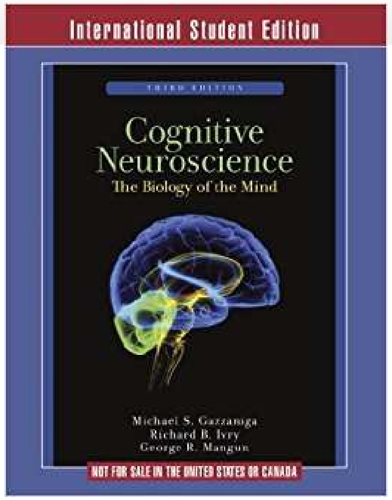
Cognitive Neuroscience, La Sapienza, May 14th 2018

Professor Randi Starrfelt, Department of Psychology, University of Copenhagen
Randi.Starrfelt@psy.ku.dk

Overview

- Introduction to developmental prosopagnosia
- Methodological issues: the weight of single cases vs group trends.
- Three studies of developmental prosopagnosia:
  - Reading (exapmple study)
  - Topographical orientation
  - Object processing
  - And a little bit about Navon' paradigm

- Statistical programs (and principles) for analysing single cases, comparing cases, and analysing dissociations: try analyses on published data.

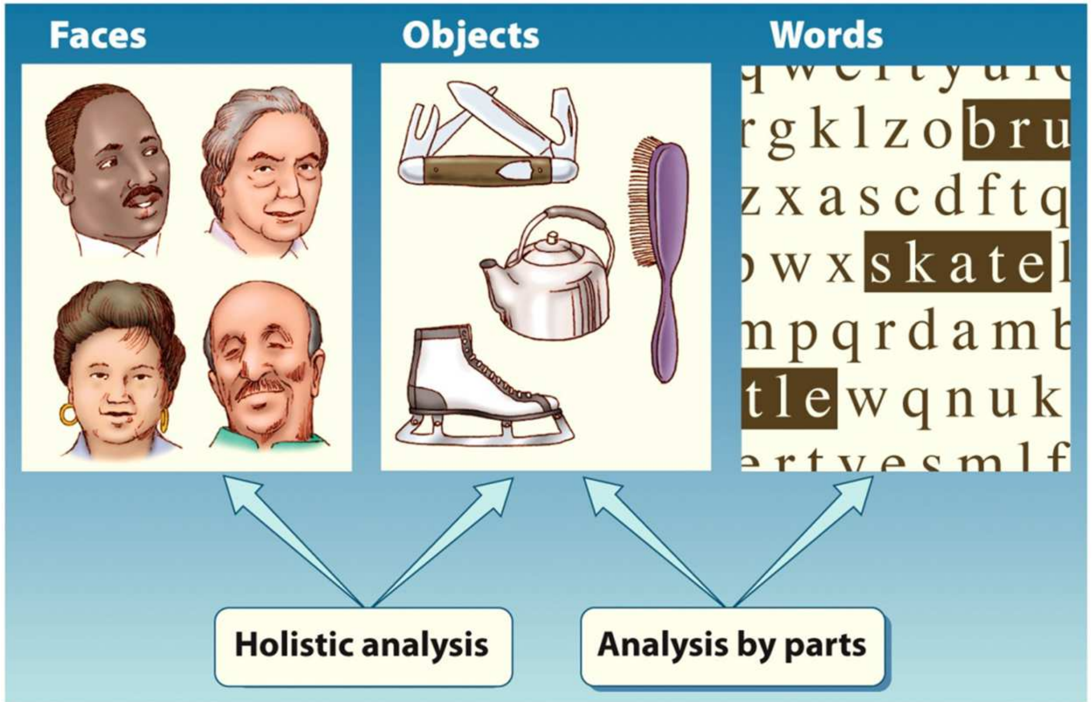


Textbook knowledge (Gazzaniga, 2014):

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)



Prosopagnosia

- A specific type of visual agnosia affecting faces.
- I.e., a disorder of face perception / recognition.
- Other aspects of visual processing and intellectual functioning intact.
- Originally for a condition following focal brain damage: acquired prosopagnosia.
- Also exists in a developmental form, which may affect up to 2.5% of the population.

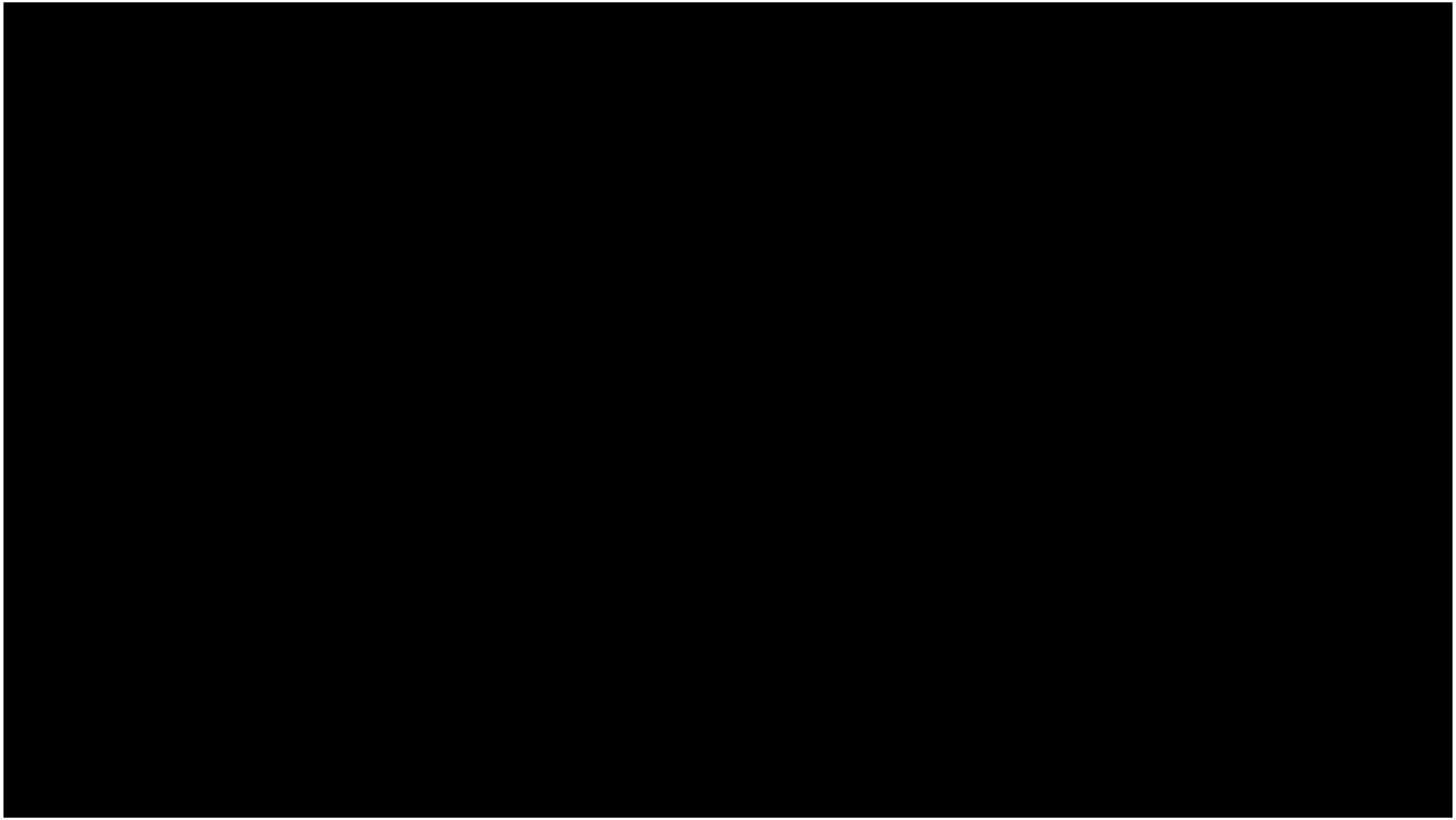
A NEUROLOGIST'S NOTEBOOK | AUGUST 30, 2010 ISSUE

FACE-BLIND

Why are some of us terrible at recognizing faces?

BY OLIVER SACKS

Oliver Sacks on faceblindness



Developmental prosopagnosia

- Definition:
  - Life long problems with recognizing people by their face
  - No (known) brain injury
  - Cannot be explained by other deficits in vision, memory or intelligence.

- Estimated to affect 2-2.5 % of the population.

- That means a child in every second class!

Typical criteria for inclusion in scientific studies

- Self report of life long problems with face recognition
- Difficulties in tests of famous face recognition, face memory (and face perception)
- Normal basic vision
- No autism or psychiatric diagnosis
- No known brain injury

- And sometimes also:
  - Demonstrated lack of focal injury on MRI

Developmental vs congenital (hereditary)

- Seems to run in families (Grueter et al., (2007) Autosomal, dominant inheritance), but not confirmed in all cases.
- Face recognition abilities in general seem to have a genetic component

Wilmer et al. (2010) *PNAS*

What is the core problem?

- Well, what's so special about faces?

- Face recognition is automatic, and seems very easy
- But faces are very complex visual stimuli that share the same configuration.

Face recognition is dependent "holistic" processing of features and second-order configurations

Difference in features

Difference in position

TEST:

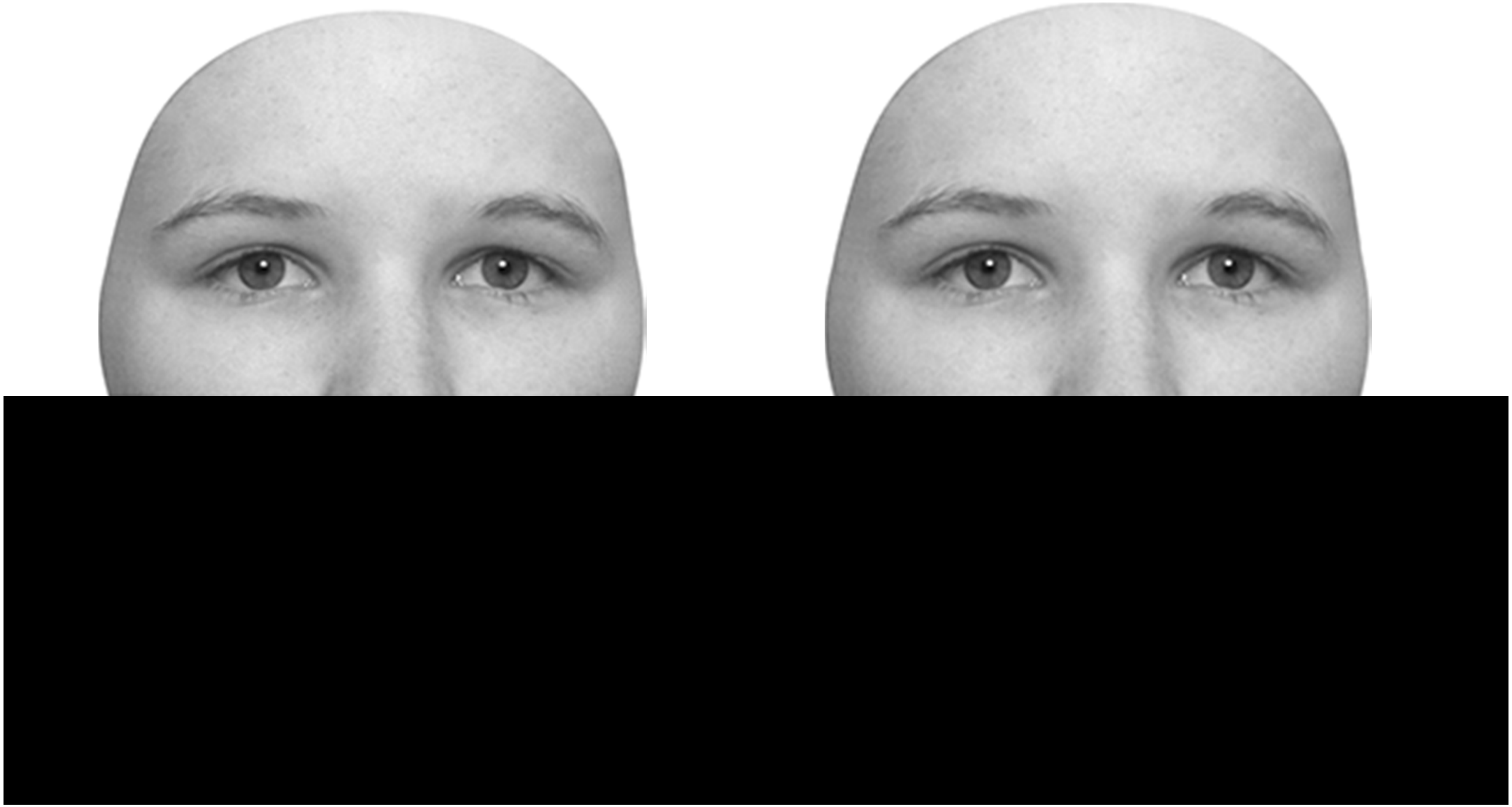
On the next slide two faces will be shown next to eachother.

Focus on the top part of the faces, and decide as fast as possible if this part of the faces are identical or not.

In other words: Ignore the bottom part of the faces.

If the upper part of the faces are identical, say YES.
If they are different, say NO.

Ansigter indkodes holistisk

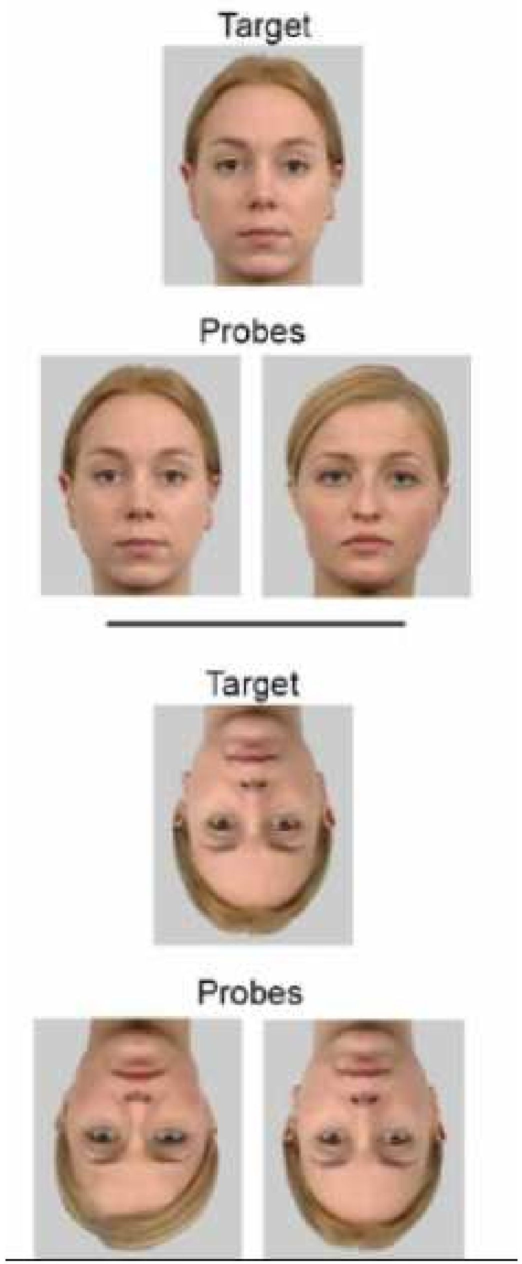


Ansigter indkodes holistisk

Holistic / configural processing is important for normal face recognition

- The "face inversion effect" is taken as evidence that automatic configural processing only occurs when faces are in a typical orientation

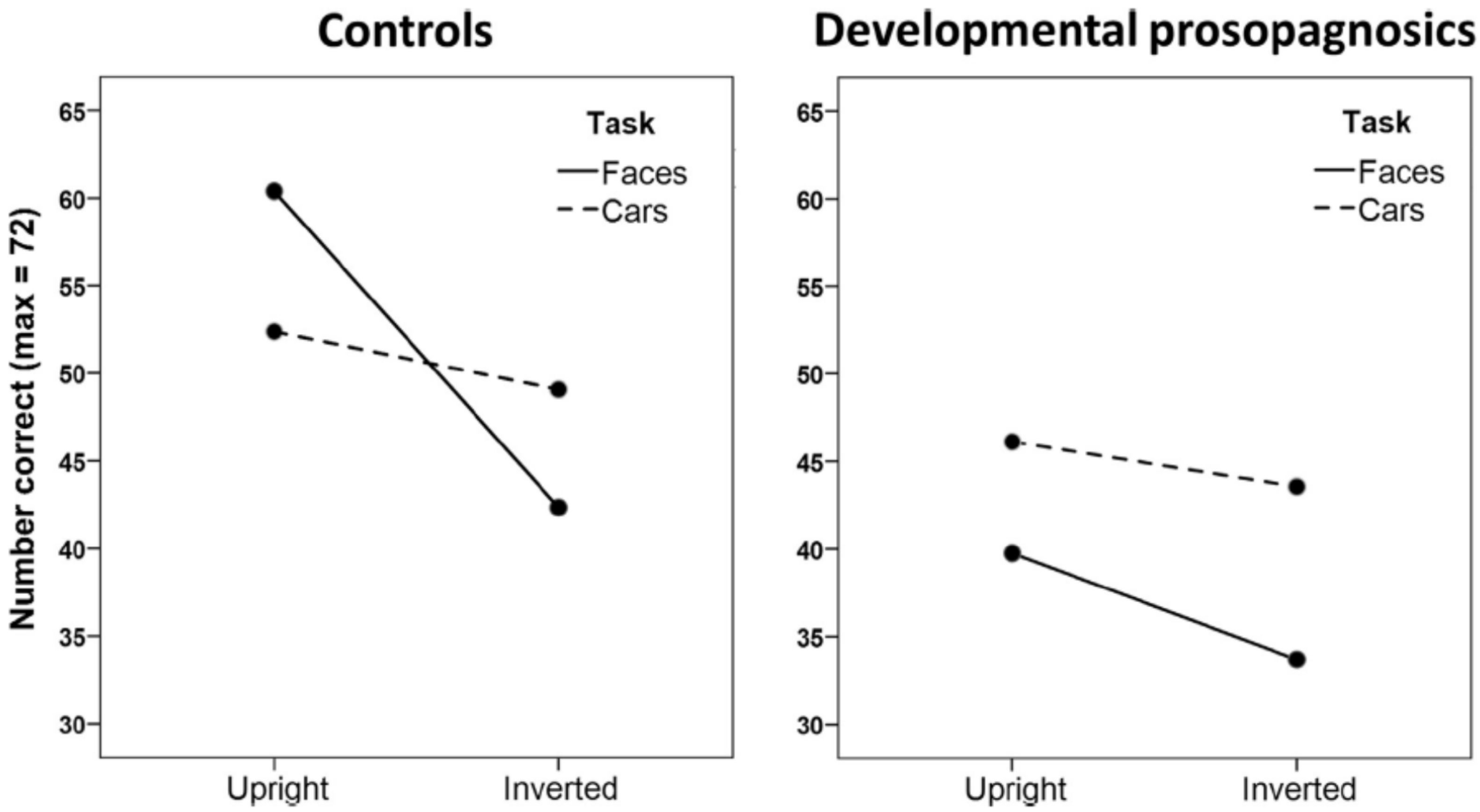
- People with prosopagnosia show a smaller inversion effect (because they are not better with upright faces)



Inversion effects for faces and objects in developmental prosopagnosia: A case series analysis

Solja K. Klargaard[a,*], Randi Starrfelt[b], Christian Gerlach[a]

Neuropsychologia 113 (2018) 52–60



N=32

N=16

- The inversion effect is large in normal subjects – but does it reflect lack of holistic / configural processing for inverted faces?

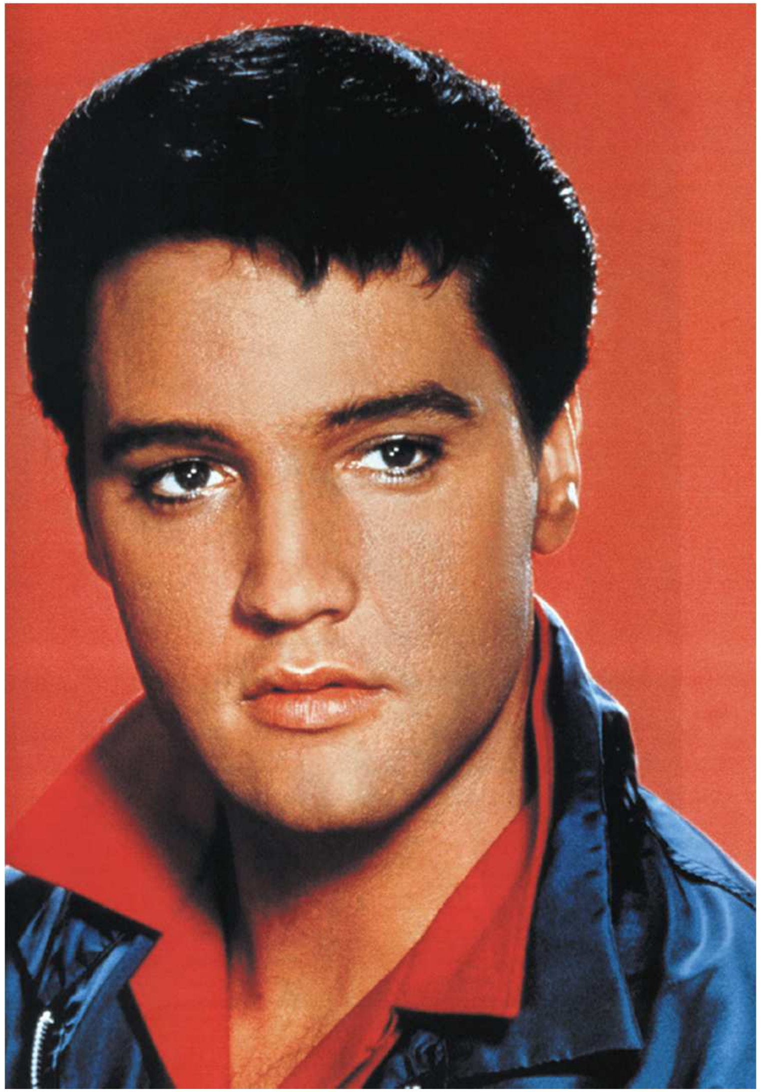
What can people with DP still do?

- Oliver Sacks:
- ..while I may be unable to recognize a particular face at a glance, I <u>can</u> recognize various things about a face: that there is a large nose, a pointed chin, tufted eyebrows, or protruded ears.
- I am reasonably good at judging age and gender.
- I am far better at recognizing people by the way they move.
- I am sensitive to the beauty of faces, <u>and to their expressions.</u>

Tests of face recognition to "diagnose" DP

- Famous faces
- Cambridge Face Memory Test (CFMT)
- Cambridge Face Perception Test (CFPT)
- 20 item prosopagnosia index (Questionnaire. PI20)
- Faces and emotions questionnaire (FEQ)
- [CCMT]

Famous faces

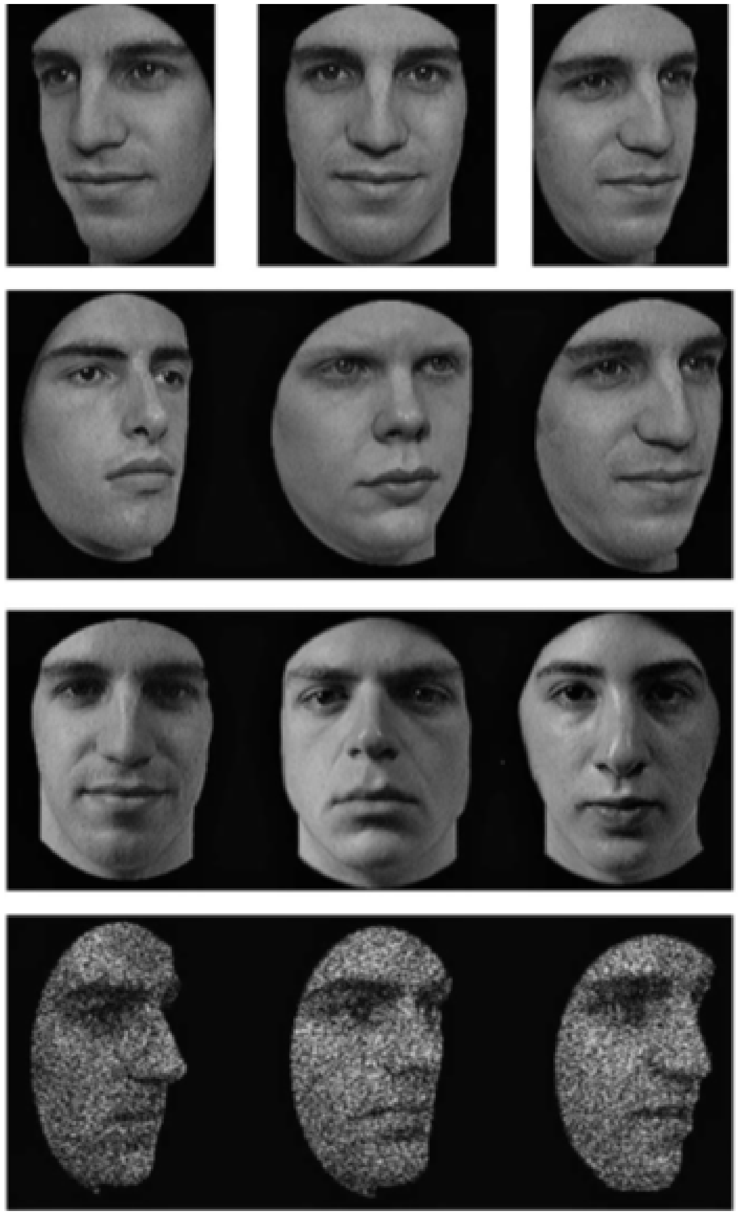


Making famous faces more difficult





Cambridge Face Memory Test (CFMT)



Examples

1: Identical faces / views

2: New images / views of same face

3: "New" images / views with noise

Several versions available:
CFMT (original)
CFMT – Australian
CFMT – Chinese
CFMT – Female
CFMT – Kids
CFMT – small kids

and more..

Translated to many languages

Duchaine & Nakayama (2006) *Neuropsychologia*

CFMT online
(commonly used for screening purposes)

http://www.bbk.ac.uk/psychology/psychologyexperiments/experiments/facememorytest/startup.php

Cambridge Face Memory Test

Birkbeck UNIVERSITY OF LONDON

Welcome to Cambridge Face Memory Test

In the following task you will be required to memorize the faces of different individuals. You will then be asked to identify a face you memorized out of a line-up of three faces. The test will begin with a very easy practice round and then will become progressively more challenging. Instructions will be given throughout the task, please follow them carefully. The test will take approximately 20 minutes to complete.

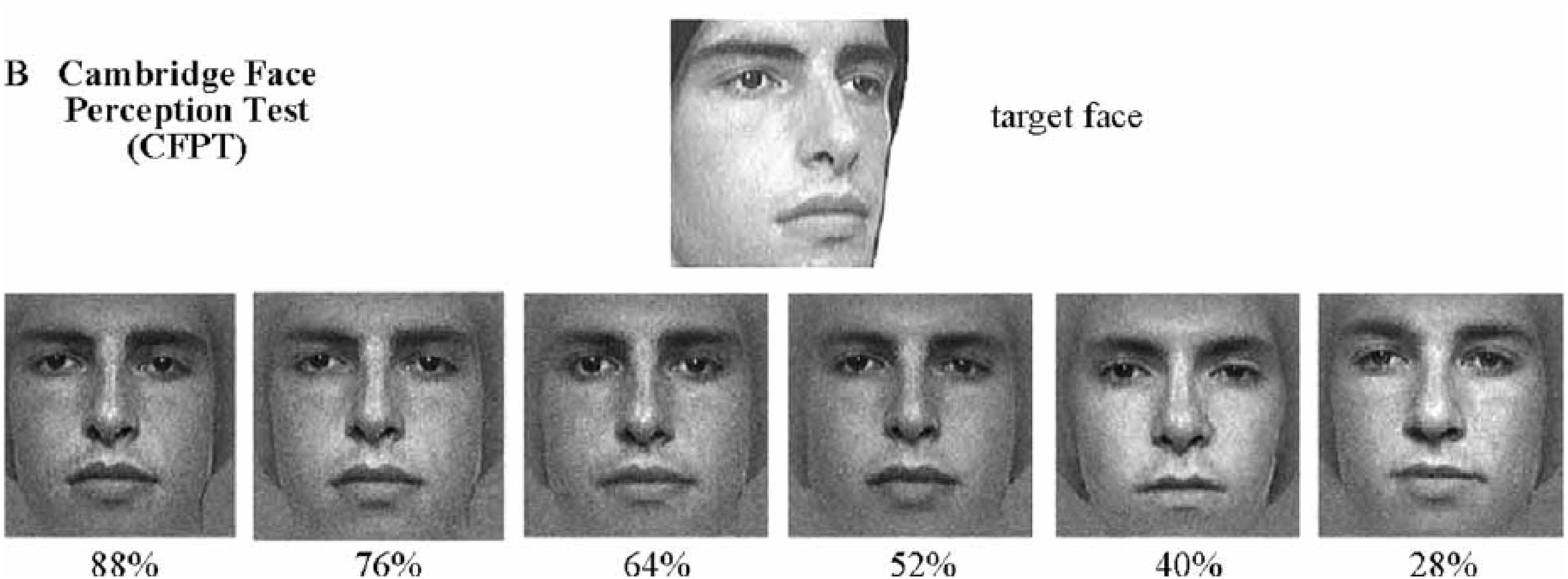
If you have any questions about this on-line test or if you wish to lodge a complaint or concern, please contact Rebecca Nako (r.nako@bbk.ac.uk).

If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, click on the "I Agree" button to begin the experiment.

I Agree

A matched test with objects (within category discrimination)
Cambridge Car Memory Test (CCMT)

Cambridge Face Perception test (CFPT)



20 item prosopagnosia index (PI20)

The 20 statements comprising the PI20, shown with the mean scores for the TD controls and suspected prosopagnosics for each item.

		controls	troubled
1	My face recognition ability is worse than most people	1.88 (*0.89*)	4.66 (*0.51*)
2	I have always had a bad memory for faces	1.88 (*0.96*)	4.55 (*0.74*)
3	I find it notably easier to recognize people who have distinctive facial features	3.69 (*1.11*)	4.31 (*1.00*)
4	I often mistake people I have met before for strangers	1.90 (*1.04*)	4.54 (*0.70*)
5	When I was at school I struggled to recognize my classmates	1.34 (*0.72*)	3.43 (*1.25*)
6	When people change their hairstyle, or wear hats, I have problems recognizing them	1.86 (*0.95*)	4.33 (*0.86*)
7	I sometimes have to warn new people I meet that I am 'bad with faces'	1.47 (*0.85*)	4.12 (*1.07*)
8*	I find it easy to picture individual faces in my mind	2.38 (*1.16*)	4.25 (*0.96*)
9*	I am better than most people at putting a 'name to a face'	2.76 (*1.17*)	4.55 (*0.80*)
10	Without hearing people's voices, I struggle to recognize them	1.66 (*0.87*)	3.78 (*1.03*)
11	Anxiety about face recognition has led me to avoid certain social or professional situations	1.36 (*0.79*)	3.76 (*1.27*)
12	I have to try harder than other people to memorize faces	1.84 (*1.03*)	4.43 (*0.76*)

Shah et al. (2015) Royal Society open sci, 2: 140393

http://rsos.royalsocietypublishing.org/content/2/6/140343

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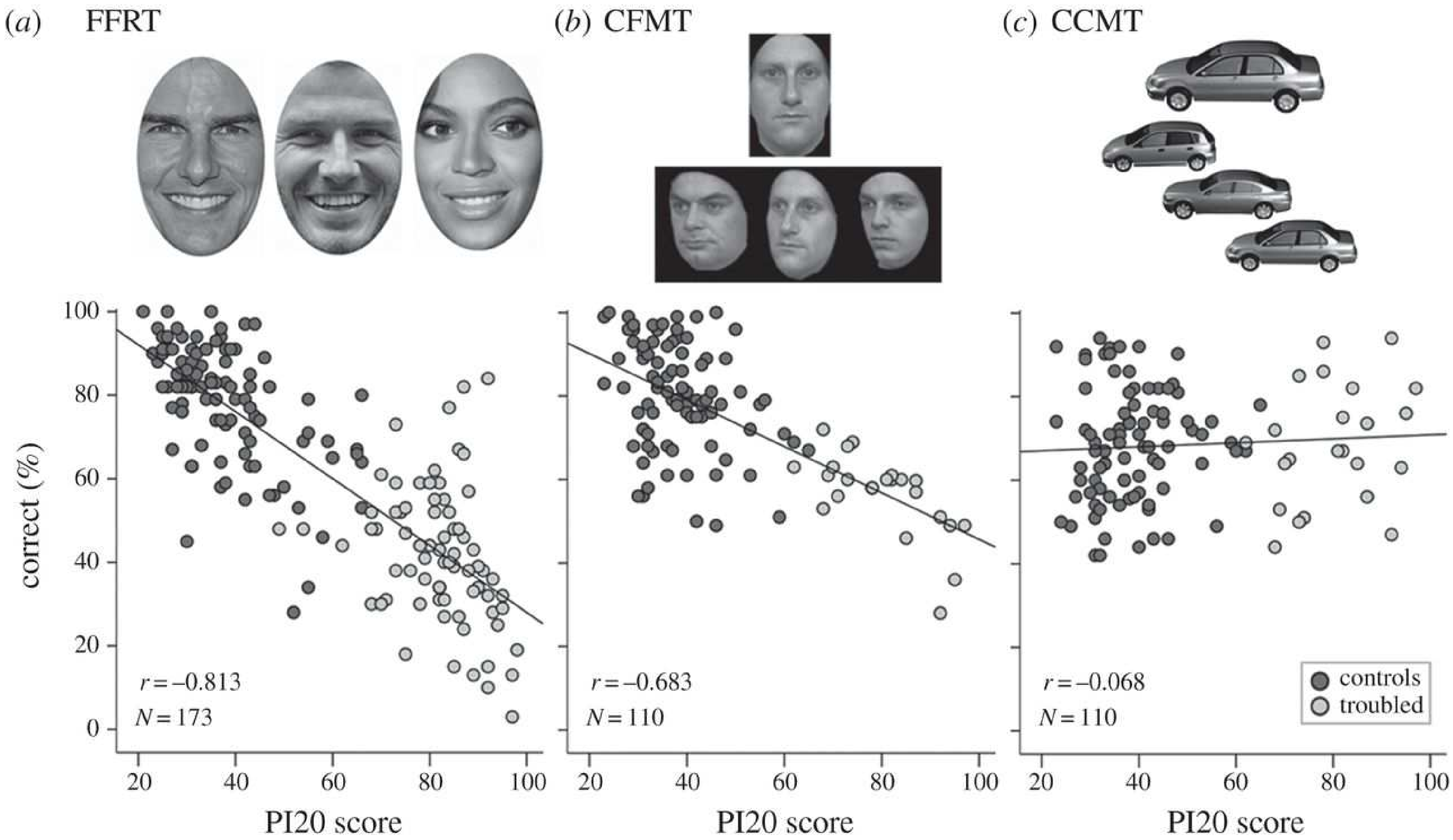
Questionnaires 1:
20 item prosopagnosia index (PI20)



Faces and emotions questionnaire

- Three parts:
  - Face Identity recognition
  - Face Emotion recognition
  - Vocal Emotion recognition

https://figshare.com/articles/Faces_and_Emotion_Questionnaire/1501441

Freeman, Palermo & Brock (2015)

Faces and emotions questionnaire

Face Identity Recognition

Please rate these statements according to your ability to identify someone purely from looking at their face.

1. I often think I recognise someone, when in fact I don't know them.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
2. I forget people even when I've met them a few times before.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
3. I rarely confuse characters in TV programs.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
4. I often have conversations with people who appear to know me, but (at least initially) I have no idea who they were.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
5. I can immediately decide if a face seems familiar.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
6. I can easily recognise famous actors in films.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
7. I usually recognise my friends in old photographs.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
8. People comment on my failure to recognise them.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
9. I don't always recognise my parents.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree

Single case studies vs group studies or case series

J Cogn Neurosci. 1997 Fall;9(5):555-604. doi: 10.1162/jocn.1997.9.5.555.

What Is Special about Face Recognition? Nineteen Experiments on a Person with Visual Object Agnosia and Dyslexia but Normal Face Recognition.

Moscovitch M[1], Winocur G, Behrmann M.

1) Many experiments on one patient

2) Some experiments on some patients / subjects

3) Few experiments on many patients / subjects

For 2 and 3, the grouping principle is important (e.g., syndrome, lesion location, common symptom?

Case series are different from group studies

- Single case studies
- Multiple case studies
- Case series (individual and group data + pattern)

The goal of a case series is to explain the variation in the primary measures taken from a patient sample in order to draw inferences about cognitive functions. Mean scores in themselves may not be very informative.

Schwartz & Dell

- In a **single-case study**, the variability comes from the many tests that are administered to the patient. Some tests reveal deficits (to varying degrees), and others do not. This variation allows the researcher to draw conclusions.

- The same applies to a **case series**, except that there are more cases, but typically fewer tests. The variability in patient performance on the tests and, particularly, the covariation between tests, provide the basis for scientific inference

Statistical methods are available for

1) Comparing a single case to controls: Is there a deficit?

2) Comparing a patient's results on two tests, with reference to controls: Is there a dissociation between tasks?

3) Comparing two cases with reference to controls: is there a dissociation between patients?

4) [With vs without covariates]

Are other functions affected in developmental prosopgnosia?

- Generally, developmental disorders often co-occur, but developmental prosopagnosia can be dissociated from:

- Autism / ASD

- Dyslexia

But are there (more subtle) deficits in other domains?

A note on autism /ASD in relation to prosopagnosia

- Autism / ASD:
  - While face processing deficits are commonly associated with autism spectrum disorders, such disorders is an exclusion criterion for the "diagnosis" of developmental prosopagnosia.
  - People with prosopagnosia often – but not always – withdraw from social situations, but for different reasons than people with ASD
  - Not impaired on tests of social cognition / theory of mind / emotion recognition

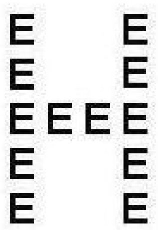
Patterns of impaired and preserved functions in developmental prosopagnosia

- Reading (words and text)

- Visual attention (unrelated items)

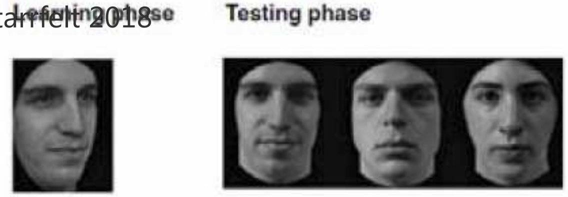
- Scene perception and memory

- Object recognition



- Navon’s paradigm

Cambridge Face Memory Test
(Duchaine & Nakayama, 2006)

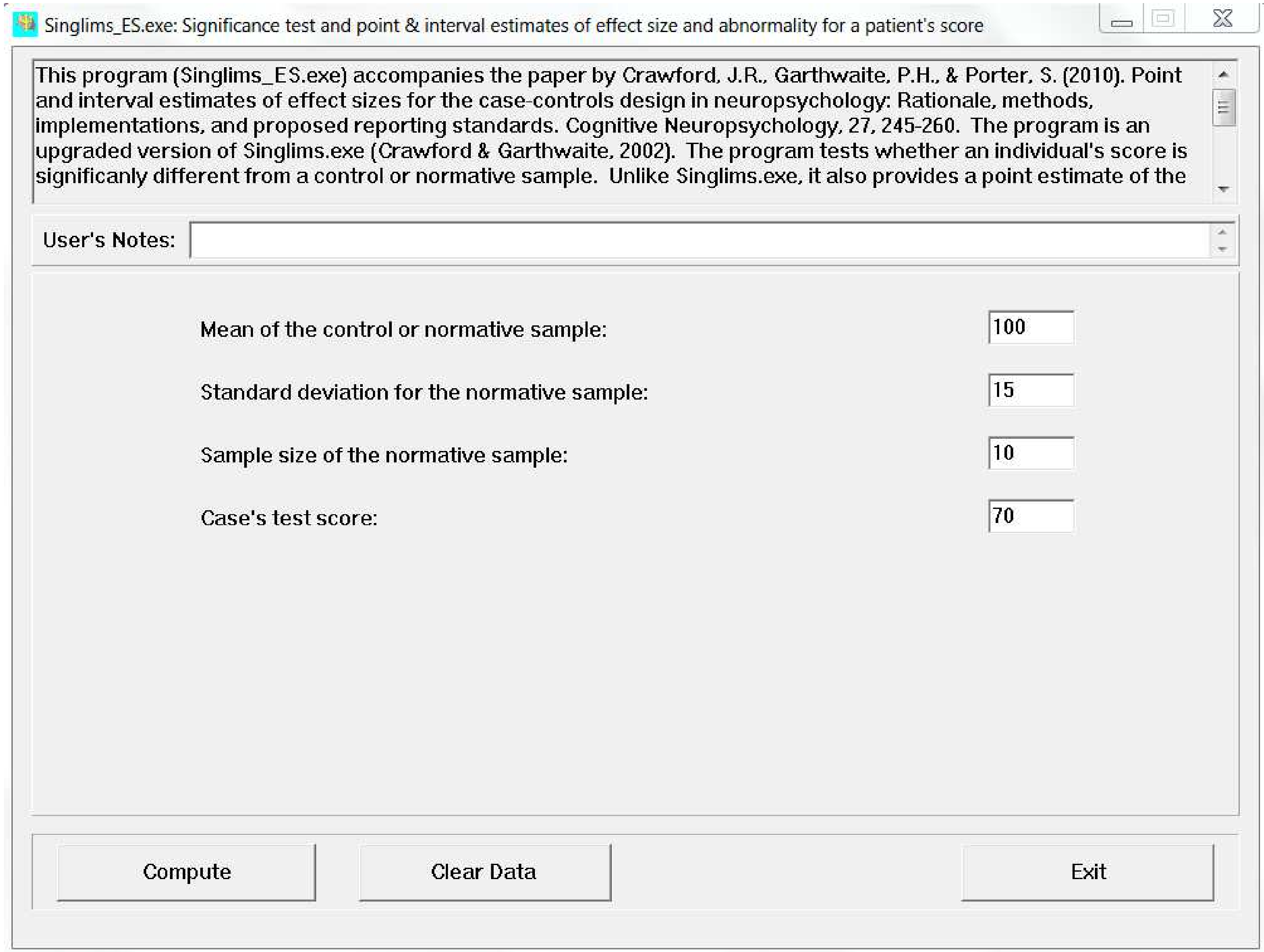


Participants:
10 DPs
20 controls matched on gender, age and education

Subject	Age	Gender	Handedn.	CFMT	CFPT	FEQ
PP04	57	M	Right	**37**	**86**	**71**
PP07	40	F	Right	**41**	60	**66**
PP09	40	F	Left	**43**	**70**	**52**
PP10	34	F	Right	**33**	58	**62**
PP13	51	M	Right	**35**	42	**64**
PP16	23	F	Left	**39**	**64**	**54**
PP17	49	F	Right	**35**	**88**	**56**
PP18	38	F	Left	**30**	**78**	**69**
PP19	16	M	Right	**33**	48	**53**
PP27	25	M	Right	**42**	**66**	**59**
Ctrl Mean (SD)	37		(3 left)	59.1 (7.9)	41.3 (11.4)	22.4 (11.4)

BOLD = impaired (2 SD)

Single case statistics 1: Comparing a case to controls: Which data do we need?



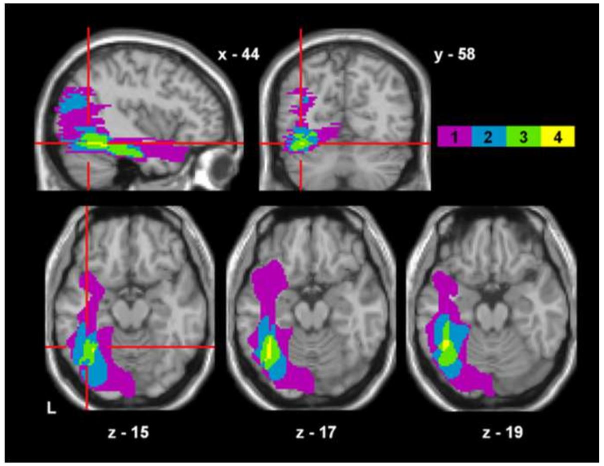
Which mean scores do we want?

- The mean and SD of control means (not all control data).
- Compared to the mean of the patient / subject

What is preserved in developmental prosopagnosia 1: Reading

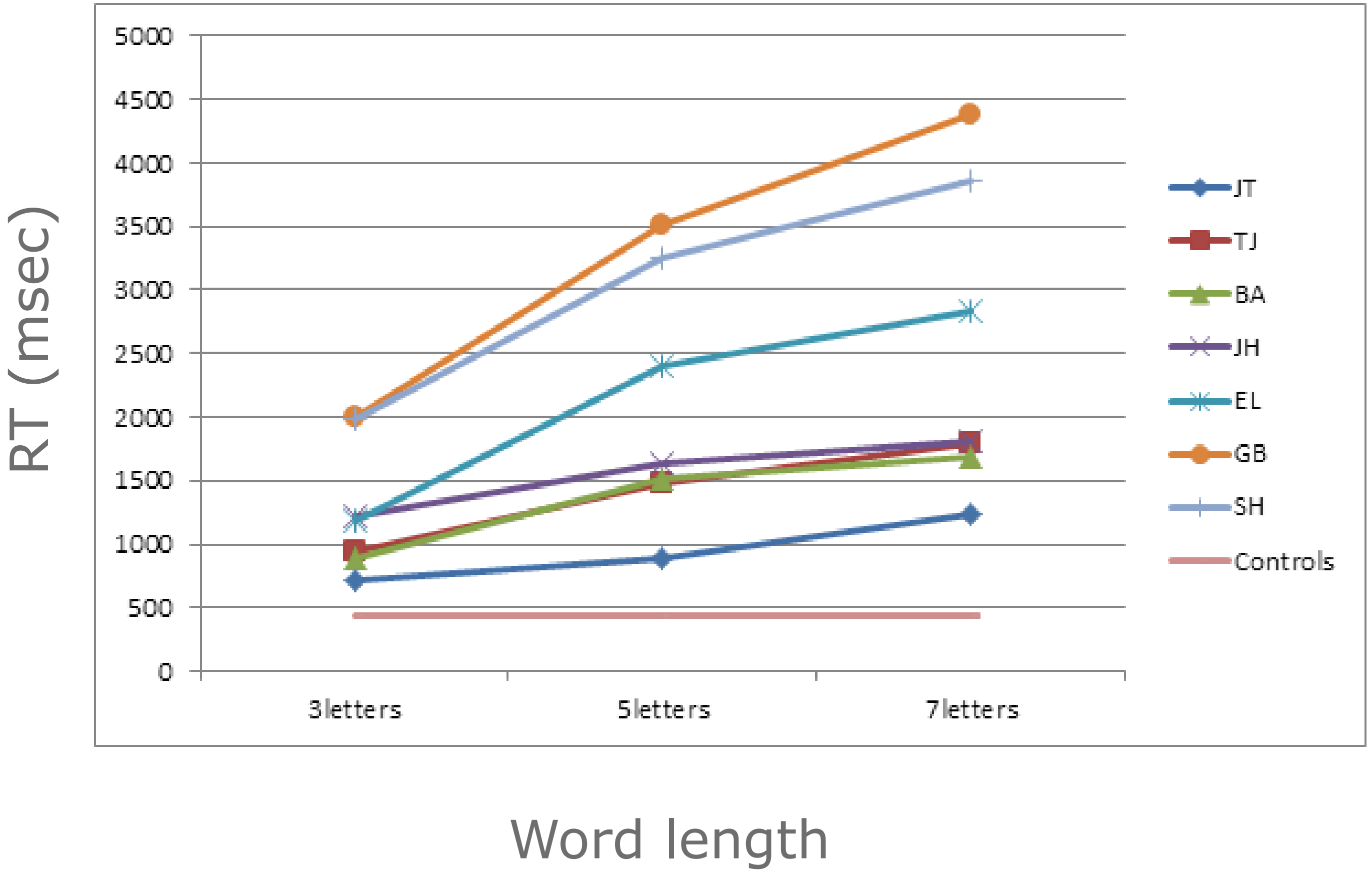
- Word length effect / RT
- Word superiority effect
- Text reading

Measure 1: The word length effect.

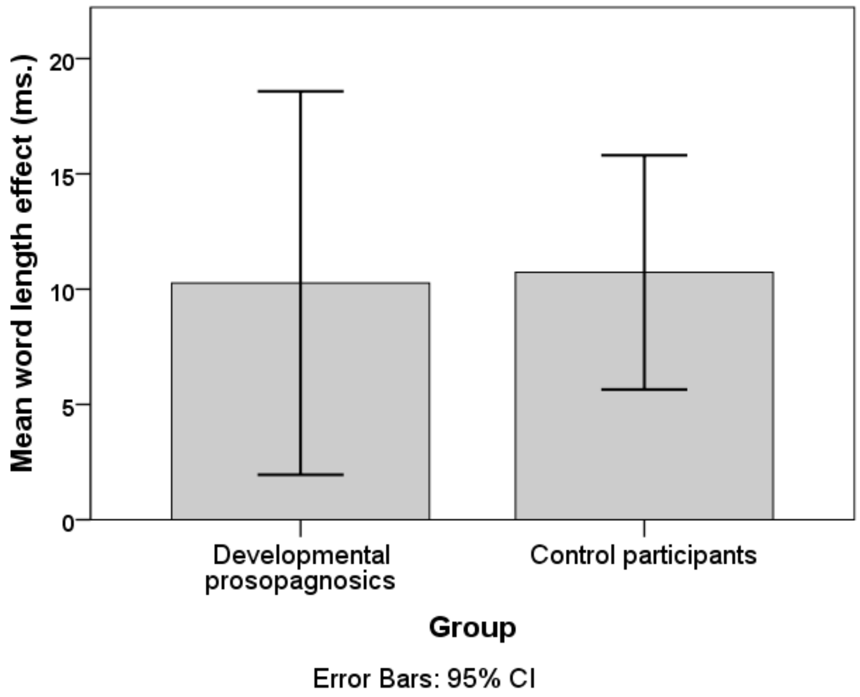


- Common symptom of acquired reading disorders.

- Pattern seen in pure alexia:



Experiment 1: Word reading / word length effect in DP

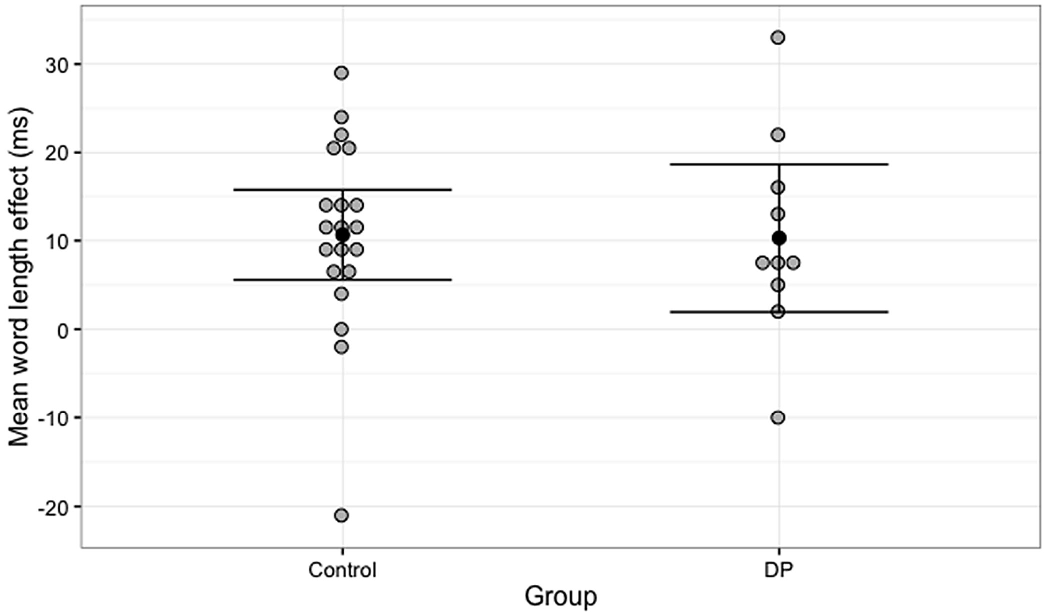


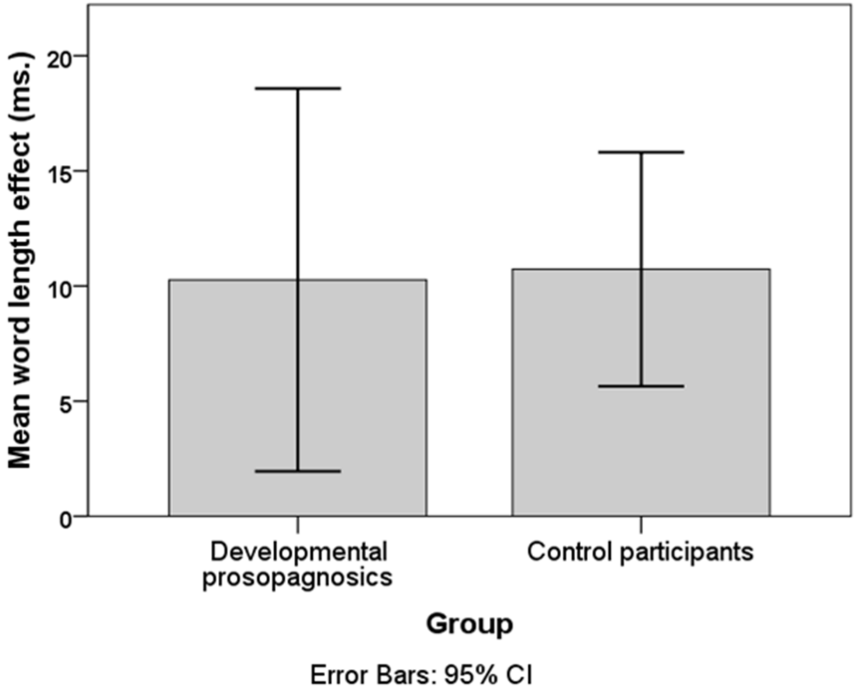
Stimuli:
- 150 high frequency words
- 5 – 7 letters.

Vocal RTs measured with voice key.

	DP	Controls	*P*
Mean RT (SD)	569 (74)	521 (68)	ns.
Word length effect (SD)	10 ms (11)	11 ms (11)	ns.

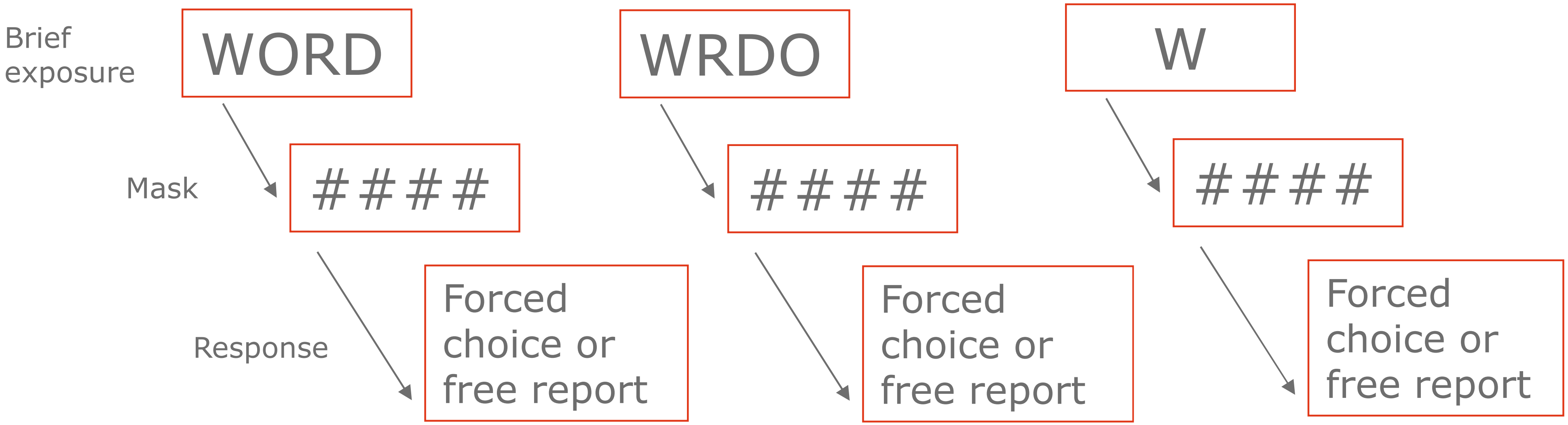
Another way of showing the same data





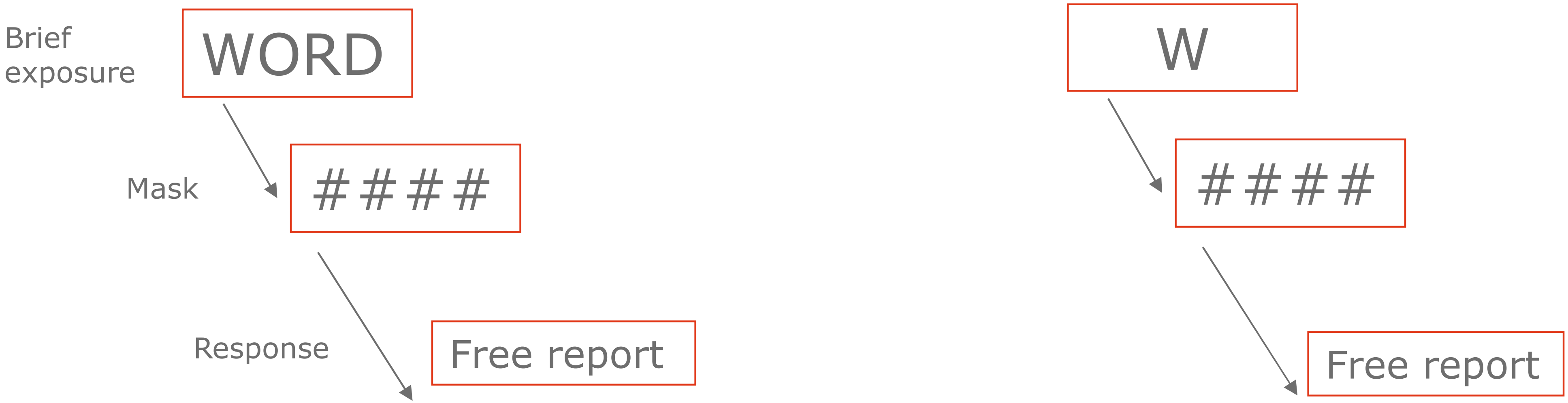
Measure 2: Word superiority effect (WSE)

- Normal performance: words > nonwords ≥ letters
- Thought to reflect parallel letter processing and top-down enhancement.



Measure 2: Word superiority effect (WSE)

- The focus of our work is on words > letters



Experiments 2a and 2b: Stimuli

25 single letters (not w)

25 highly confusable, high frequency, three letter words.

bag	bog	dag	den	det
dig	din	dit	fad	far
fod	for	han	hun	kan
kun	mad	man	med	mig
min	mod	mor	tag	tog

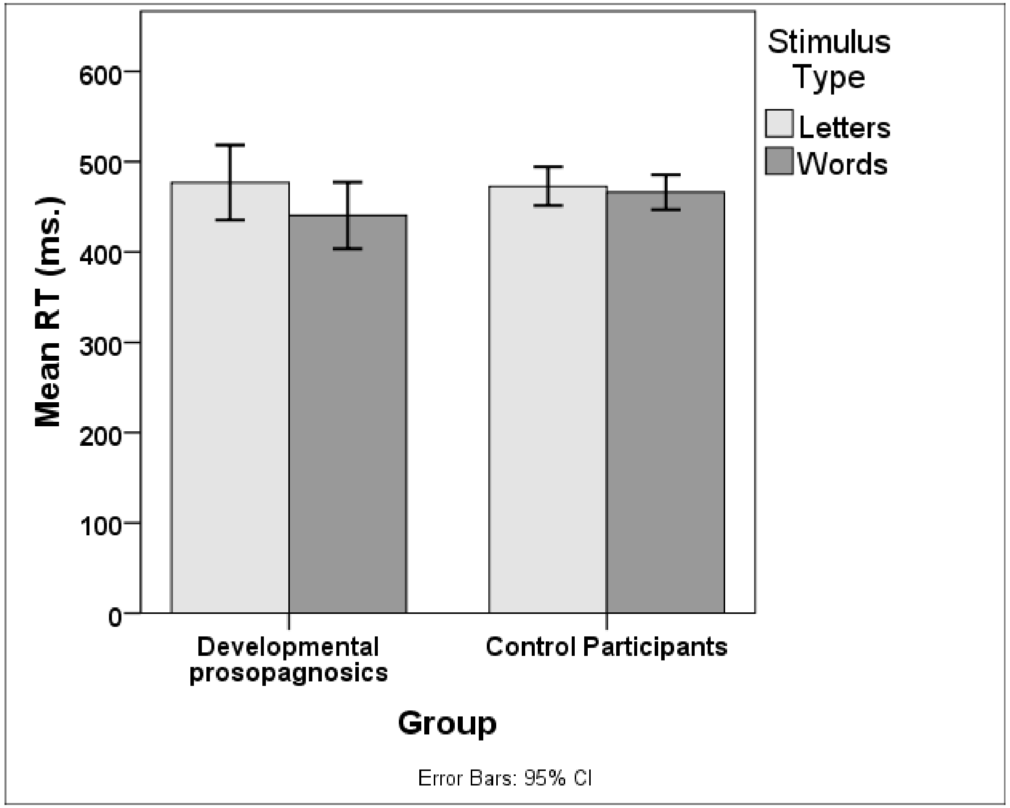
Experiment 2a: Word and letter naming.

- To familiarise subjects with the 25 words.

- Letters and words in separate blocks.

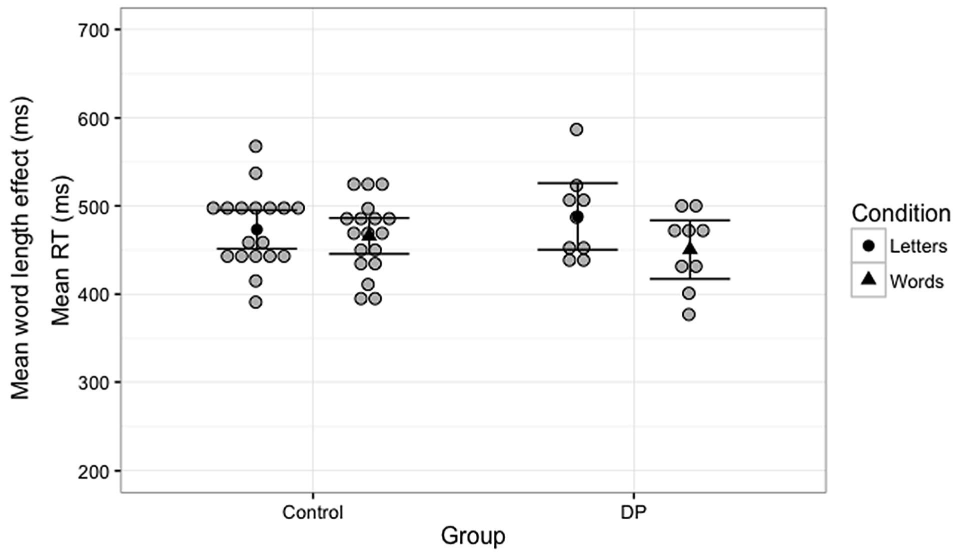
- RTs measured by voice key,

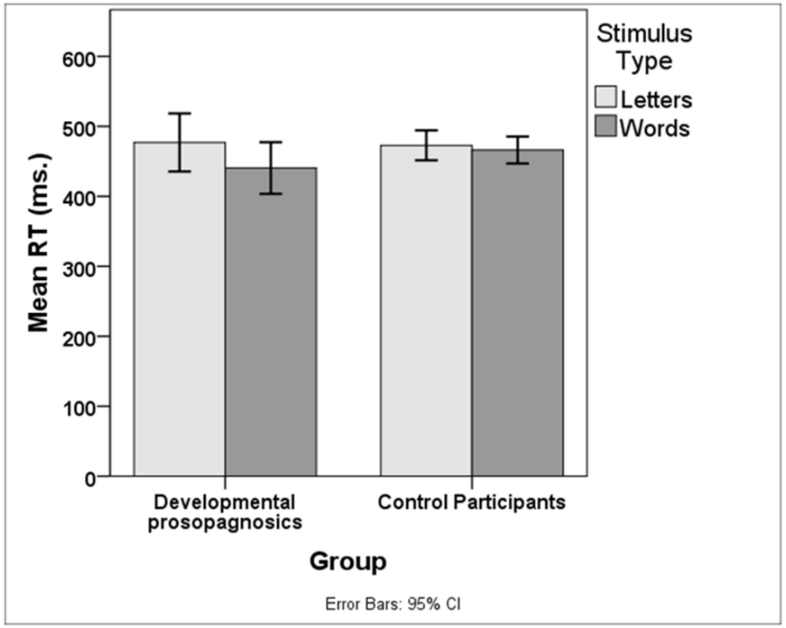
Experiment 2a: Word and letter naming.



	Words (SD)	Letters (SD)	WSE sign.
Ctrls	466 (41)	473 (46)	*p* =.39
DP	440 (52)	477 (58)	*p* = .008

With all individual data

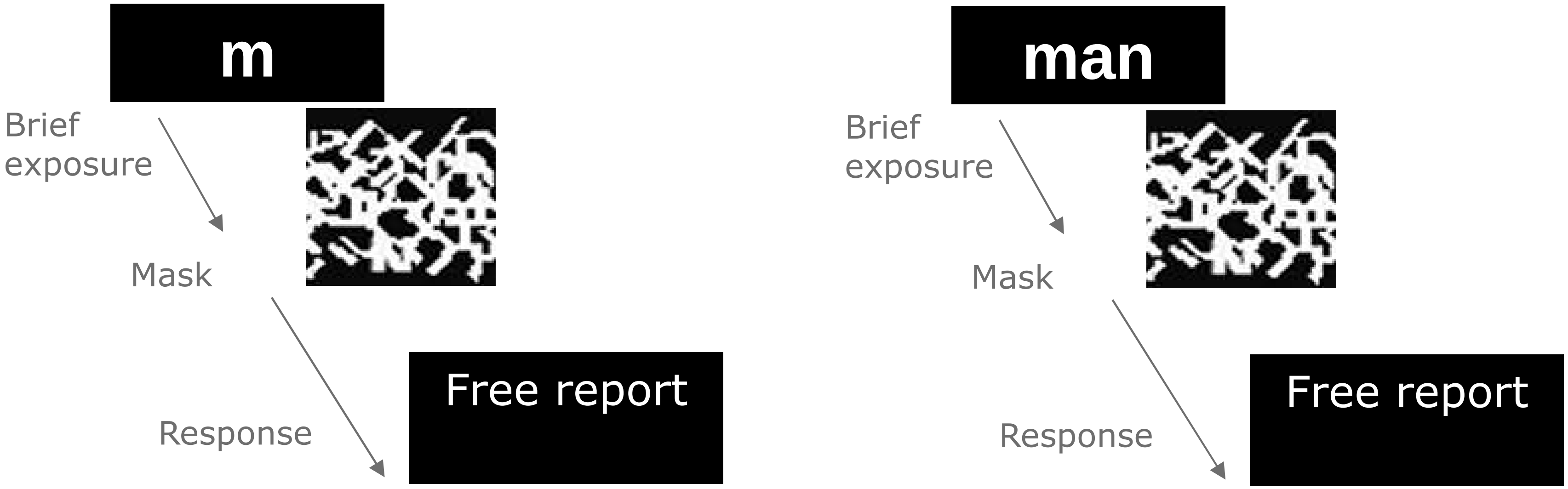




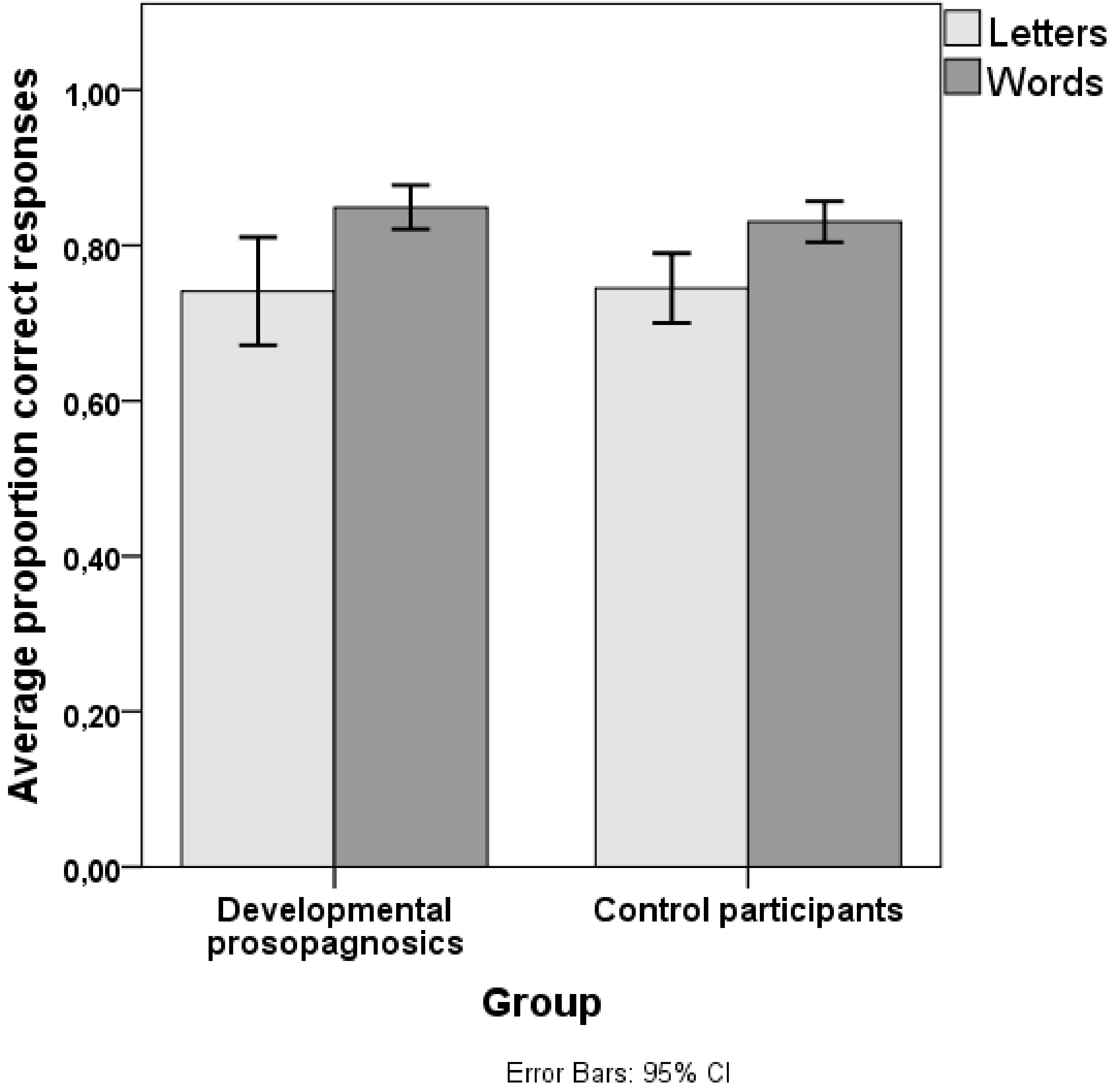
Experiment 2b: Word superiority - psychophysics

400 trials per stimulus type (20 per exposure duration).

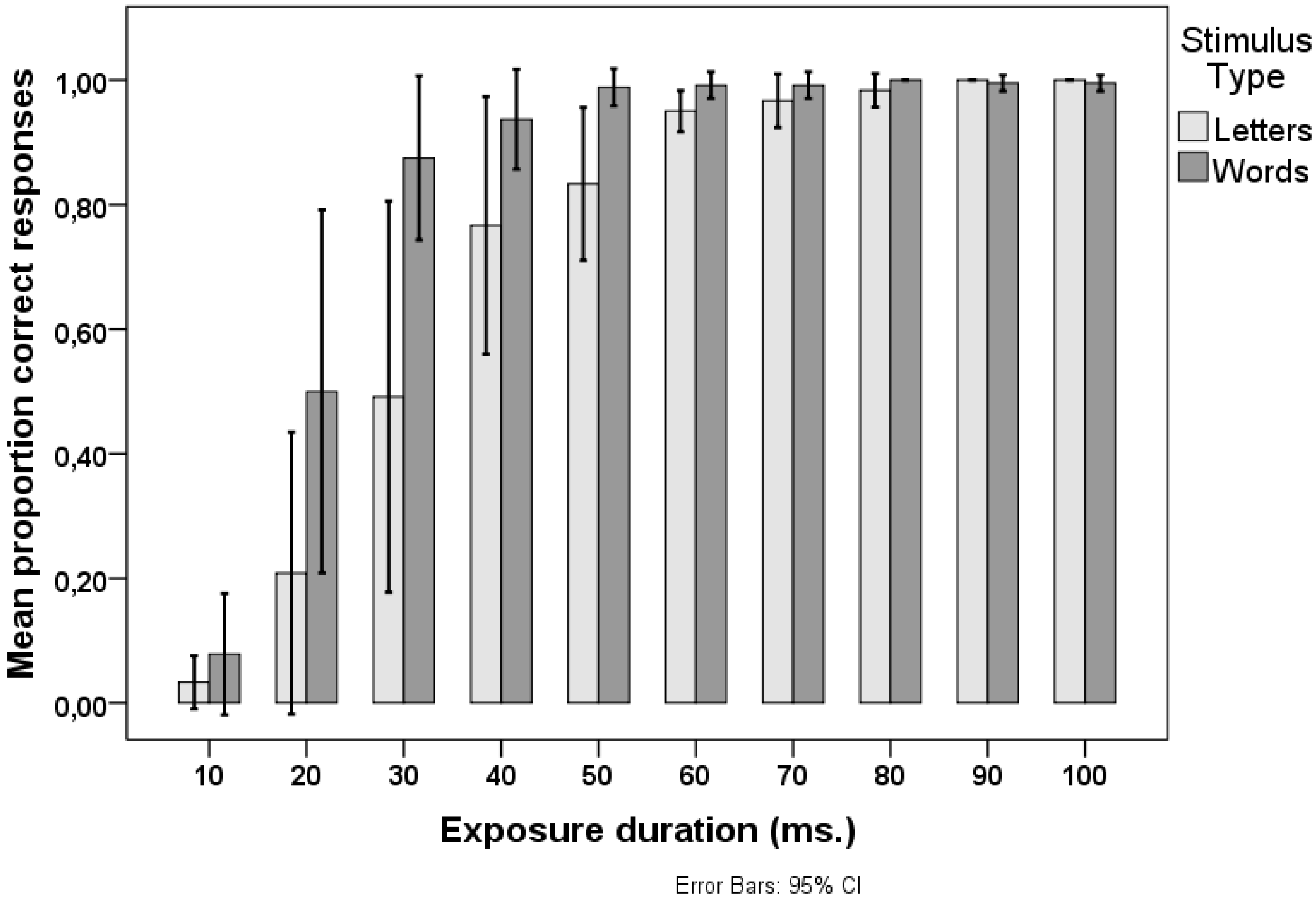
Exposure durations:
10, 20, 30, 40, 50, 60, 70, 80, 90, 100 ms randomly intermixed.



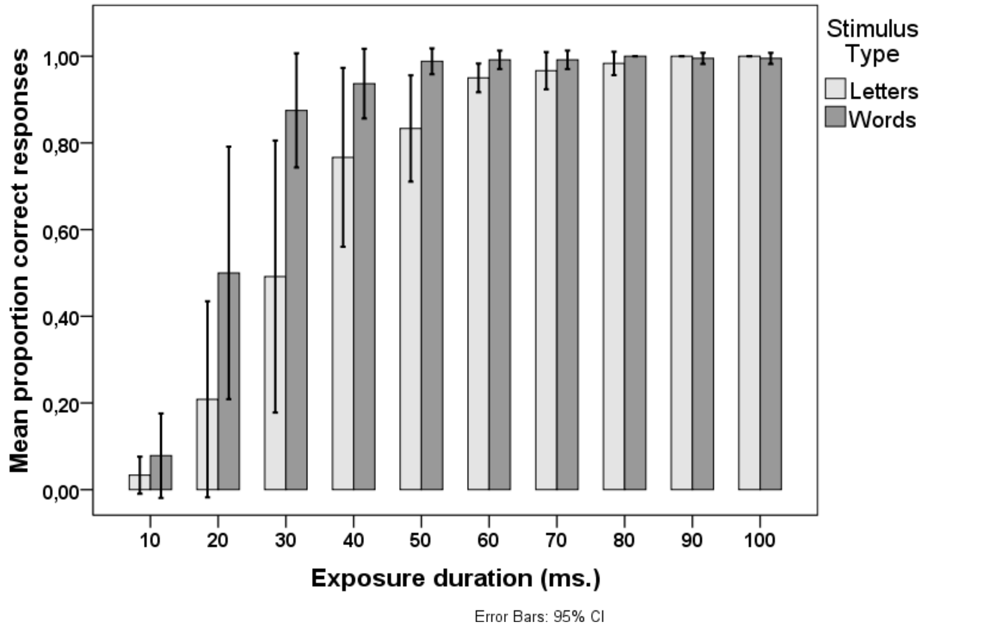
Experiment 2b results: Overall accuracy (DP = 9; Ctrls = 18)



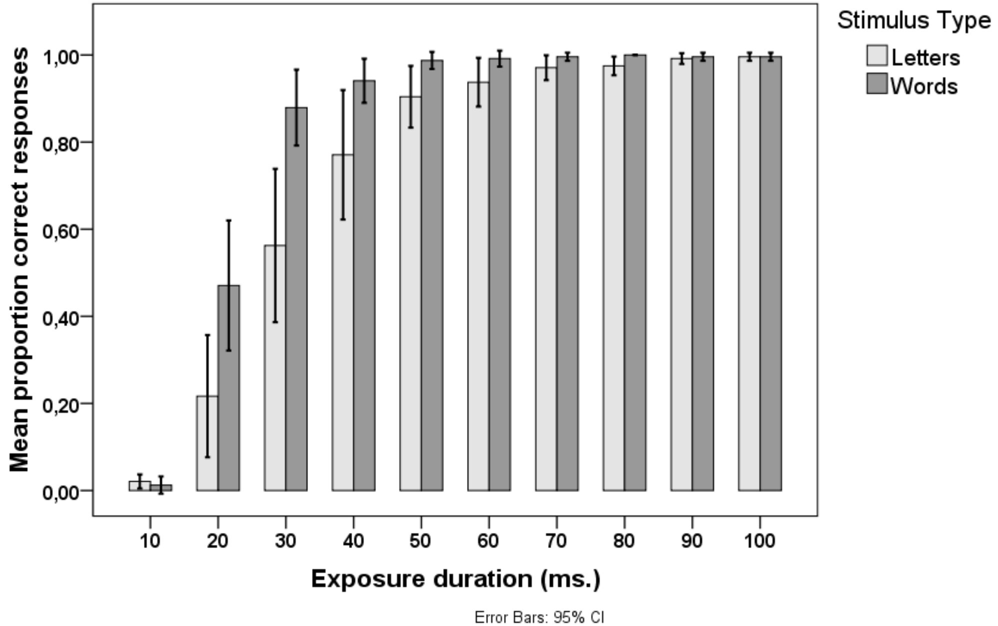
Experiment 2b results:
Word superiority in developmental prosopagnosia (n=6)



Experiment 2b results: Word superiority



DP (n=6)



Ctrls (n=12)

”Real reading” - a third experiment

- Test adapted from 9th grade reading test (by Wilms & Nielsen, 2014).
- Poupular scientific (difficult) text of 640 words followed by four comprehension questions.
- Measures reading time and comprehension (Q’s correct),

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- Poupular scientific (difficult) text of 640 words followed by four comprehension questions.
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	DP (*n* = 9)	Controls (*n*=18)	*p*
Time / sec (range)	210 (150-291)	213 (151 – 354)	ns.
Q’s correct (range)	2.67 (1-4)	2.56 (1-4)	ns.

Summary

The developmental prosopagnosics show:

- Normal reading RTs.
- Normal (absence of a) word length effect.
- Normal RTs in word and letter naming.
- Normal Word Superiority Effect.
- Normal text reading speed and comprehension.

Is this a dissociation or a ”null finding”?

Is this a dissociation or a ”null finding”? Single case statistics

Subject	Exp1 RT (ms)	Exp1 WLE (ms)	Exp2a LetterRT (ms)	Exp2a WordRT (ms)	Exp2b Letter acc	Exp2b Word acc	Exp3 RT	Exp 3 Acc (of 4)
PP04	525	2	507	432	0,61	0,84	na	na
PP07	455	8	431	<u>377</u>	0,69	0,82	201	2
PP09	**713**	16	487	478	0,68	0,76	217	2
PP10	576	7	453	401	0,84	0,85	191	3
PP13	573	33	446	431	0,69	0,86	226	2
PP16	553	13	na	na	na	na	na	na
PP17	508	-10	523	469	0,81	0,87	291	4
PP18	616	5	**587**	495	0,63	0,85	150	2
PP19	616	22	506	505	0,89	0,91	191	3
PP27	555	7	452	466	0,84	0,88	236	2
Ctrl mean (sd)	521 (68)	10.7 (10.9)	473 (44)	465 (40)	0.73 (.09)	0.82 (.05)	221 (52)	2.6 (.8)

BOLD = significantly below controls
<u>Underlined</u> = sign. better than controls
(Crawford & Howell, 1998)

Is this a dissociation or a ”null finding”? Dissociation analysis

Comparing apples and pears: CFMT uses accuracy, not RT.

Dissociation analysis (Crawford et al., 2010) on

CFMT accuracy vs. Word recognition accuracy (psychophysics exp).

- 7/9 DPs show a significant dissociation (putatively classical) between face recognition and reading.
- The remaining two show a trend dissociation.

Revisiting: Types of dissociations

Some established dissociations are supported by double dissociations.

In many cases, however, the dissociation only goes one way.

- Because one task is harder than another?
- Because of normal processing differences?
- Because one function is localized / modular and the other is not?

Important: The aim is to support the claim that the same pattern of performance ("dissociation") observed in the patient can not be observed in the normal population.

Revisiting: Types of single dissociations (Shallice, 1988)

1) Trend dissociation: Task I is performed ***markedly*** better than Task II.
   - No control group reference.

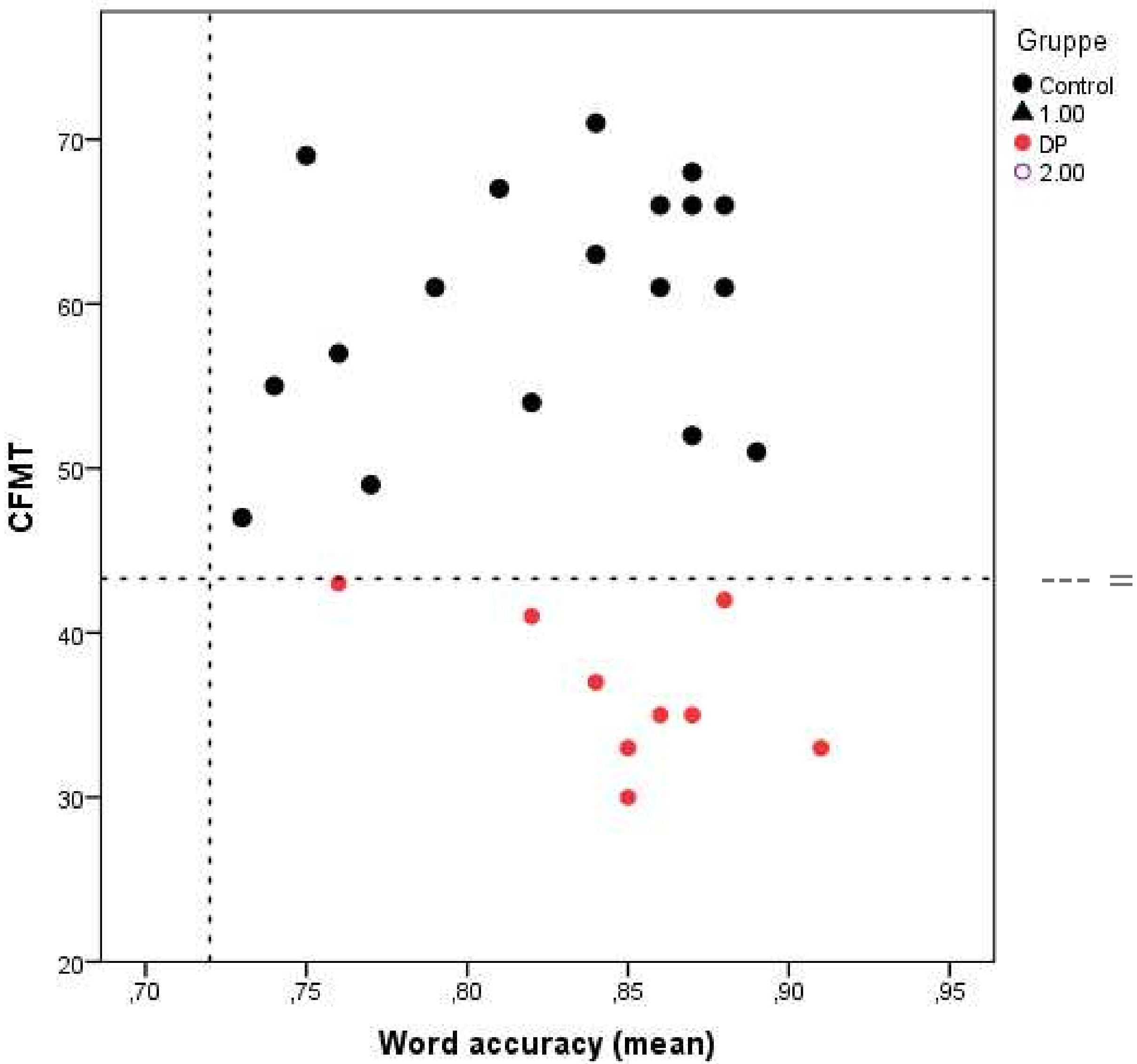
2) Strong dissociation: Neither task is performed at a normal level, but task I is performed ***very much better*** than task II.
   - Control group reference, or normals "expected to perform at ceiling level".

3) <u>Classical dissociation</u>: Task I is performed ***normally*** (compared to controls), performance on task II is impaired.

Quantitative / statistical criteria for 2) and 3) established by Crawford et al., e.g.,:

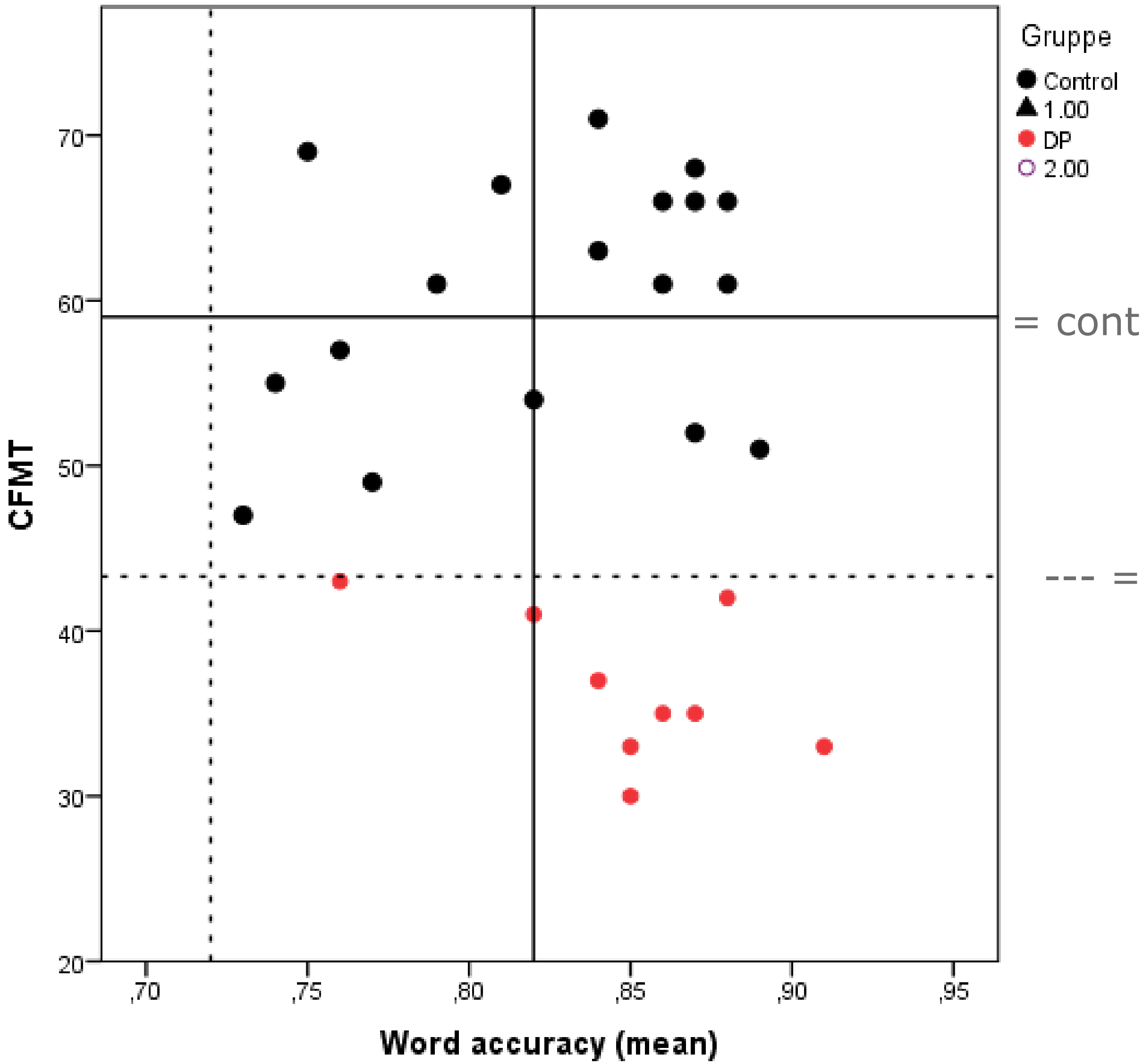
Crawford, J. R., Garthwaite, P. H. & Gray, C. D. (2003). Wanted: Fully operational definitions of dissociations in single-case studies. *Cortex, 39,* 357-370.

Face vs word recognition in DPs and controls



--- = 2sd from control mean

Face vs word recognition in DPs and controls



= control mean

--- = 2sd from control mean

How to "prove" a dissociation?

- A dissociation implies that performance is "not impaired" on one task.
- This amounts to supporting the null hypothesis (no deficit).
- Crawford's methods developed to provide positive evidence for dissociations.
  - For individuals (Dissocs)
  - For groups (DiffDef)
  - Can estimate effect sizes and confidence intervals

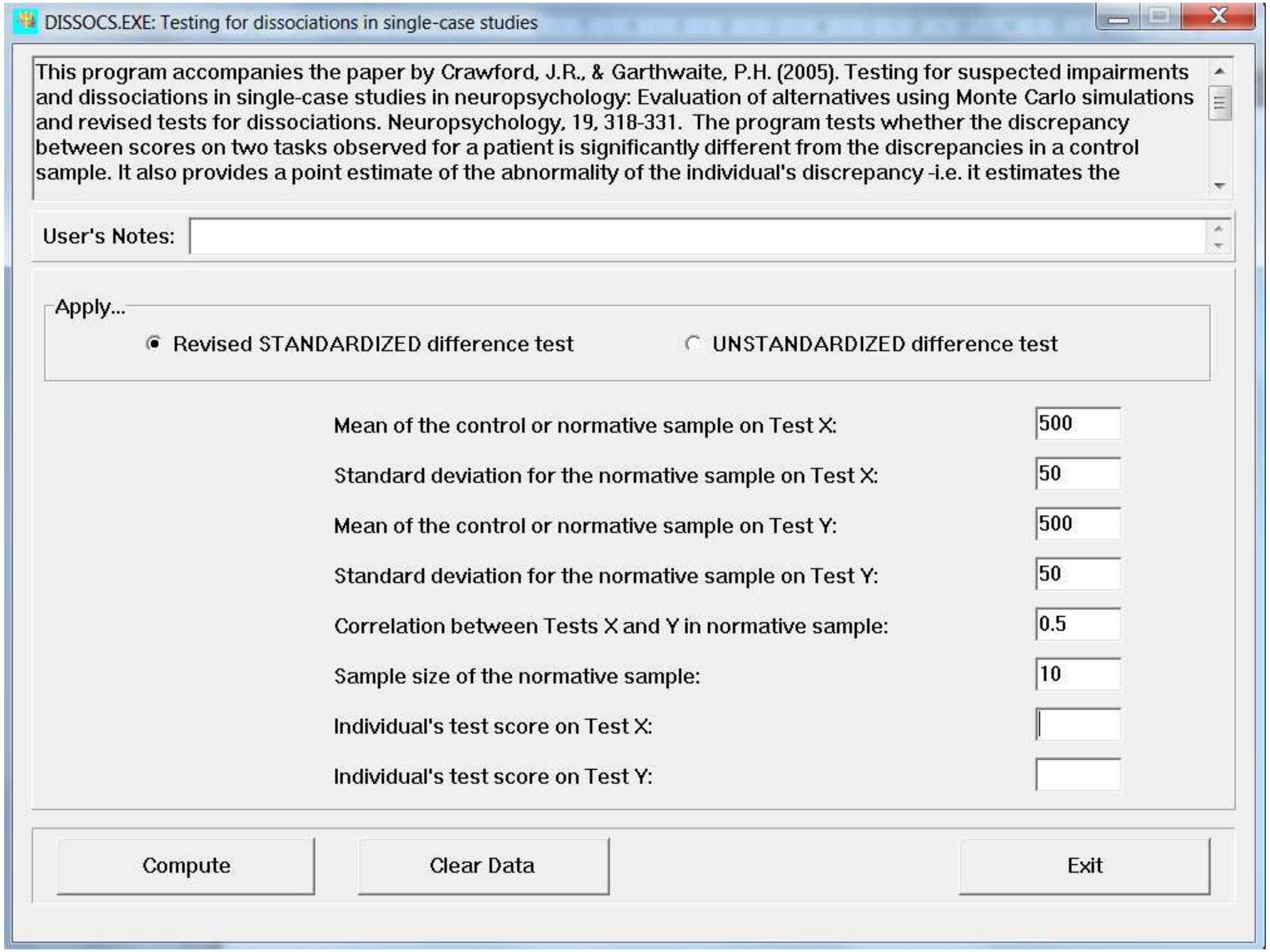
Criteria for a dissociation

1) The patient is impaired on test X

2) The patient is not impaired on test Y

3) The difference between patient's scores on X and Y are significantly different with reference to controls (the difference between X an Y is greater than can be seen in the control group / expected in the control population)

What data do we need for a dissociation analysis?

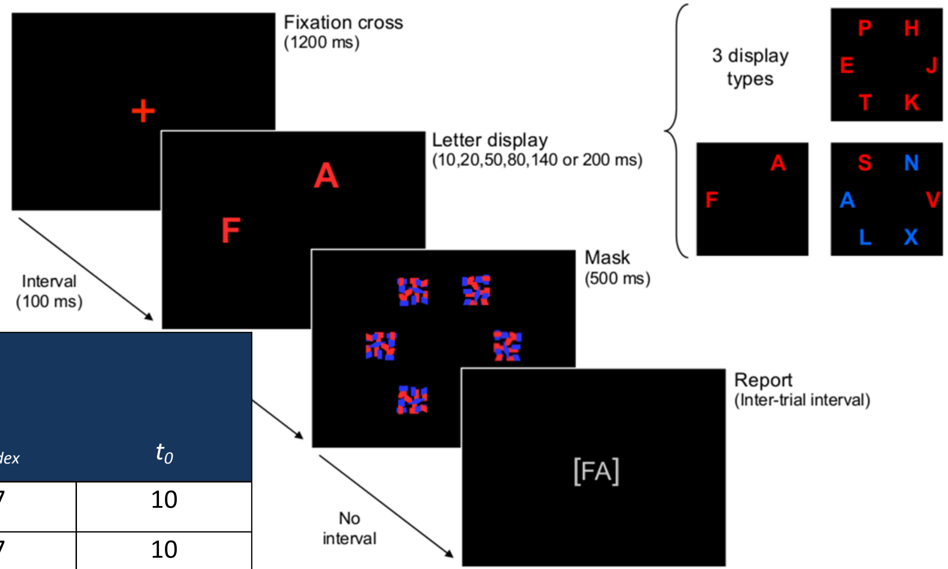


Conclusions

- There is a clear and significant dissociation between impaired face processing and preserved reading in develpomental prosopagnosia.
- A normally functioning (developing) face processing system is not a prerequisite for learning to read.
- Developmental prosopagnosics can learn to read as fluently as normal subjects, while they are seemingly unable to learn efficient strategies for recognizing faces.

What is preserved II: Visual attention (unrelated items)

- Combi TVA: Combined whole and partial report.



Attentional parameters						
Case	Age	*K*	*C*	α	W_{index}	t_0
PP04	57	4.0	73	1.09	.57	10
PP07	40	3.6	76	.95	.57	10
PP09	40	2.8	46	1.09	**.83**	30
PP10	34	1.7	27	.29	**.78**	7
PP13	51	2.6	48	1.15	.38	32
PP16	23	2.7	63	1.20	.50	28
PP17	49	3.3	63	1.20	.55	19
PP18	38	2.7	45	.89	.68	**43**
PP19	16	3.3	36	.31	.61	7
PP27	25	3.8	72	.61	.61	7
DP Mean	37	3.0	55	.88	.61	19
Control Mean	37	3.1	59	.76	.54	16
Control SD	12	.9	21	.38	.1	8

Table 1. Units for the individual parameters are *K* (letters), *C* (letters/second), α ranges from perfect selection at 0 to non-selectivity at 1, w_{index} ranges from complete rightward bias at 0 to complete leftward bias at 1 with 0.5 indicating equal weighting between the two visual fields, and t_0 (ms).

Preserved:
- attentional capacity
- processing speed,
- selecitve attention
- laterlaization index
- perceptual threshold

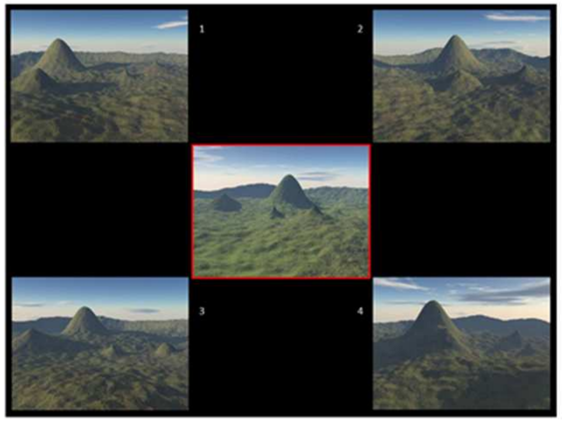
Klargaard et al. (2016), *Cognitive Neuropsychlogy*

What's (sometimes) preserved: Topographical perception / memory

- Topographical disorientation commonly associated with acquired prosopagnosia.
- Anecdotal evidence for deficit in DP.
- Four Mountains Test:

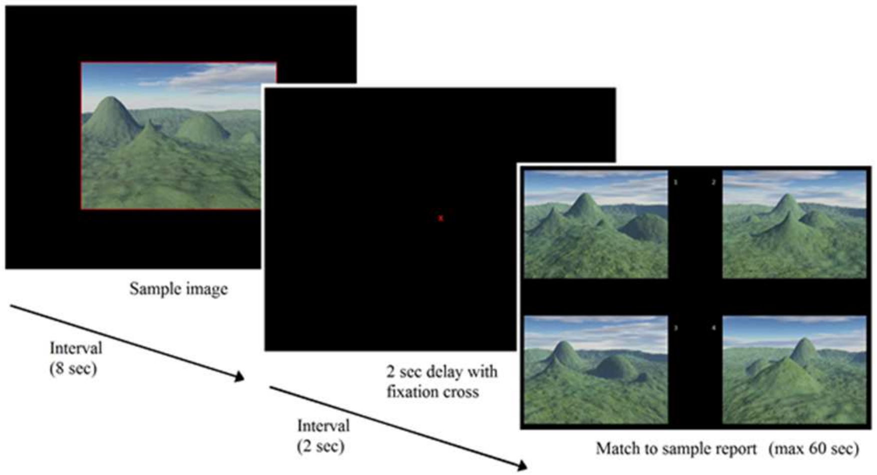
Concurrent and delayed matching of landscapes

A.



Concurrent match to sample (max 60 sec)

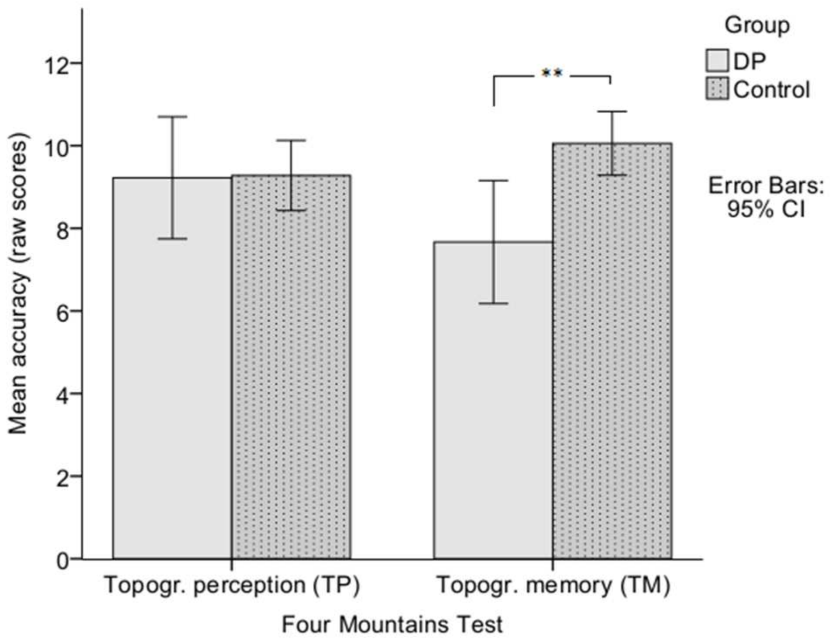
B.



Hartley et al. (2007), *Hippocampus*

What's (sometimes) preserved: Topographical perception / memory

Group results



Individually:

- 3 DPs are significantly impaired on topographical memory.
- 2 DPs fulfilled the statistical criteria for a dissociation (putatively classical) between impaired face memory and preserved topographical memory (a.m. Crawford et al., 2010).

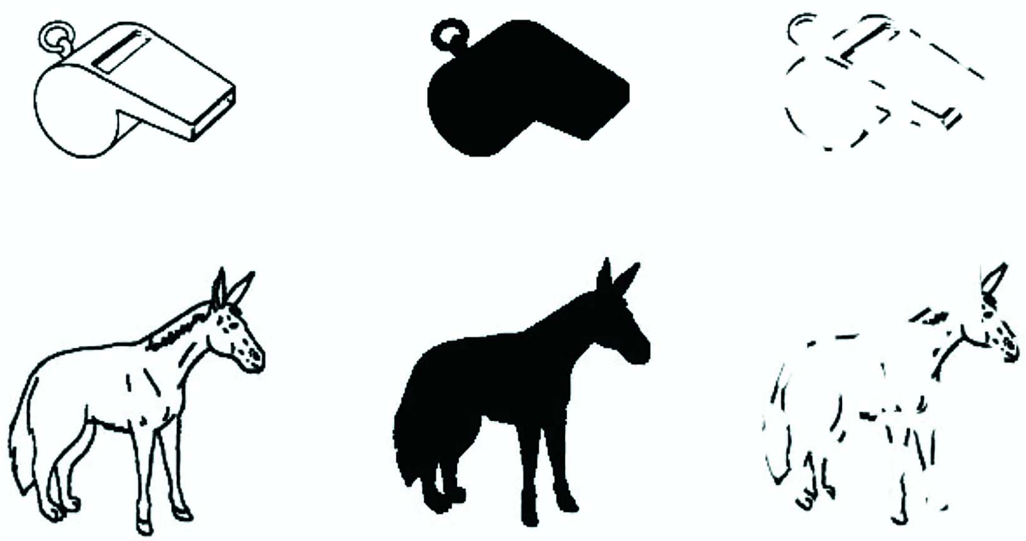
Klargaard et al. (2016), *Cognitive Neuropsychlogy*

What is (sometimes) impaired: Object recognition

- Object decision (outlines, fragmented, silhouettes)
- The Cambridge Car Memory Test - an object parallel to the Cambridge Face Memory test.
- The Faces and Houses test

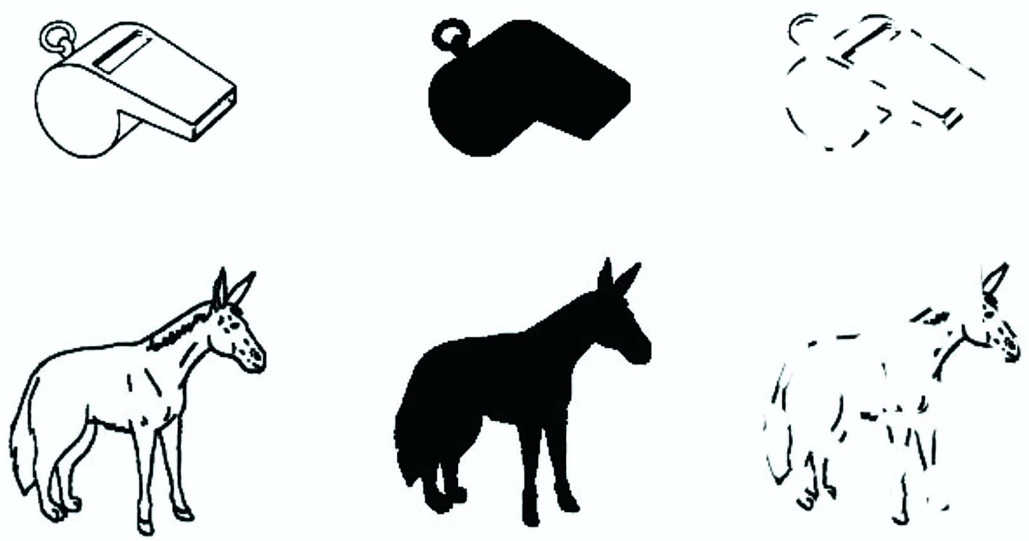
Gerlach et al. (2016) *PLOS One*

Object decision



Gerlach et al. (2016) *PLOS One*

Object decision

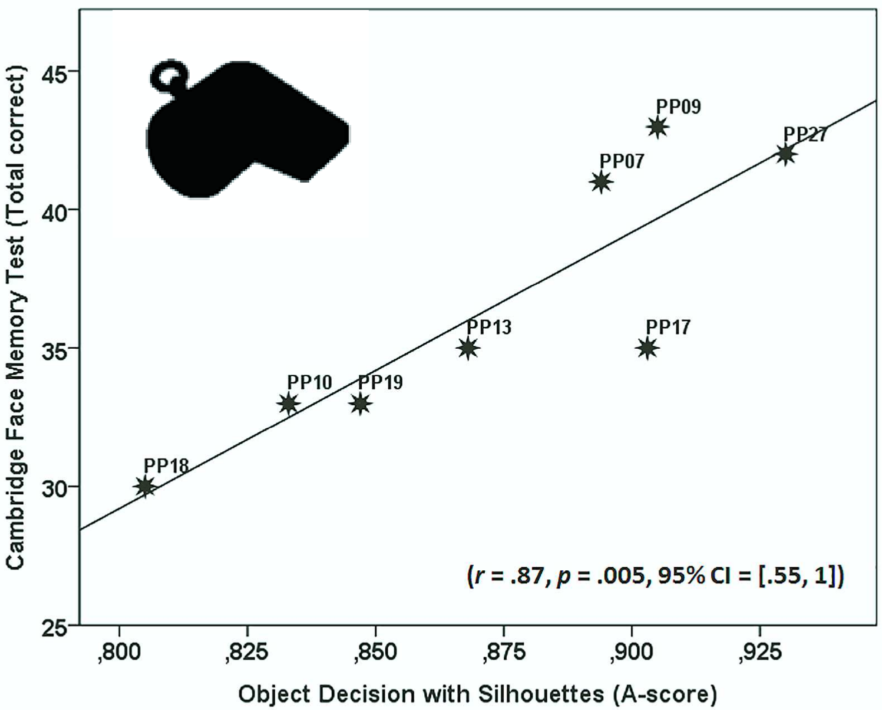


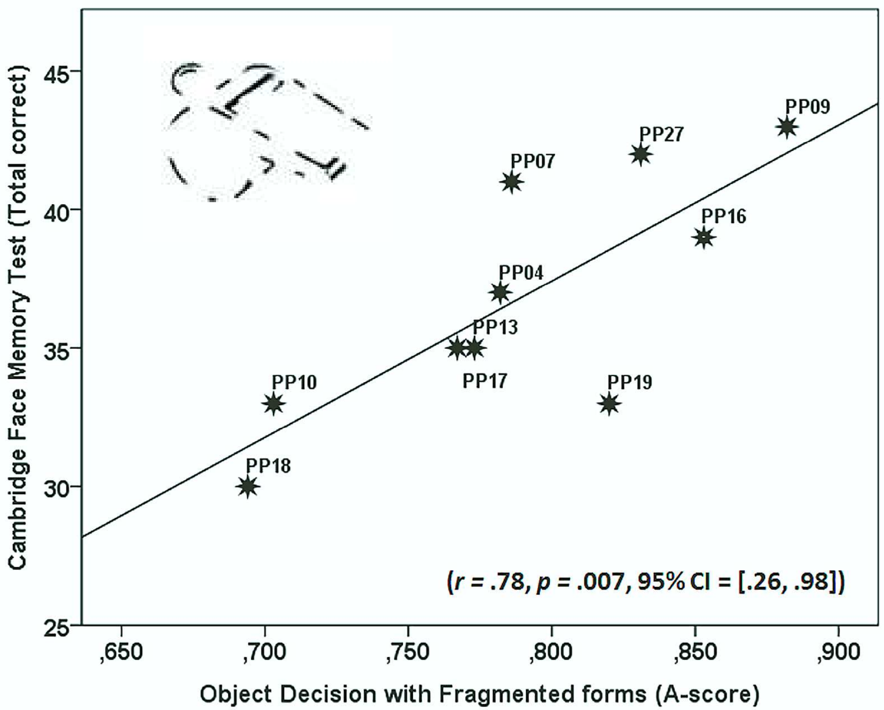
\+ ÷ ÷

None of the DP subjects showed a significant dissociation (a.m. Crafword et al., 2010) between performance with faces (CFMT) and degraded objects

Gerlach et al. (2016) *PLOS One*

Is object performance related to face performance?
Association between face memory and object decision in DP





Gerlach et al. (2016) *PLOS One*

- Reading (words and text)

  Preserved / dissociation

- Visual attention (unrelated items)

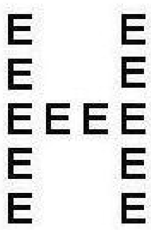
  Preserved / dissociation

- Scene perception and memory

  Preserved / dissociation (in some)

- Object recognition (degraded)

  Impaired / association



- Navon's paradigm

  Impaired / association

Discussion point:

- Can the same logic of cognitive neuropsychology be applied to developmental disorders as to acquired deficits following brain injury?

- Cognitive neuropsychology assumptions (from first lecture):
  - Aim: To create models of <u>normal</u> cognition.
  - Studies of brain injured patients cognitive deficits (and intact abilites) is the empirical foundation:
  - <u>The subtraction hypothesis:</u> Behavior of brain injured patient(s) = normal cognitive system ÷ specific function(s)
  - <u>Universality assumption:</u> All healthy cognitive systems are the same.

Try out single case statistics programs

- Look at one of the articles for today that uses Crawford's methods
- Find out which test they used
- Find the correct data for the analysis
- Run the analysis

- Do you get the same results?

Developmental prosopagnosia in children

ELSEVIER

Journal of Psychosomatic Research

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“A room full of strangers every day”: The psychosocial impact of developmental prosopagnosia on children and their families

Kirsten A. Dalrymple[a, b, 1], Kimberley Fletcher[c, d, e, 1], Sherryse Corrow[f], Roshan das Nair[g], Jason J.S. Barton[c, d, e], Albert Yonas[f], Brad Duchaine[a]

- Children and parents reported unique social and practical challenges linked to DP.

Conclusion

Our findings indicate a need for increased awareness and treatment of developmental prosopagnosia to help these children manage their face recognition difficulties and to promote their social and emotional wellbeing.

The opposite end of the spectrum: People with extremely good face recognition skills

Developmental prosopagnosia

Super-recognizers