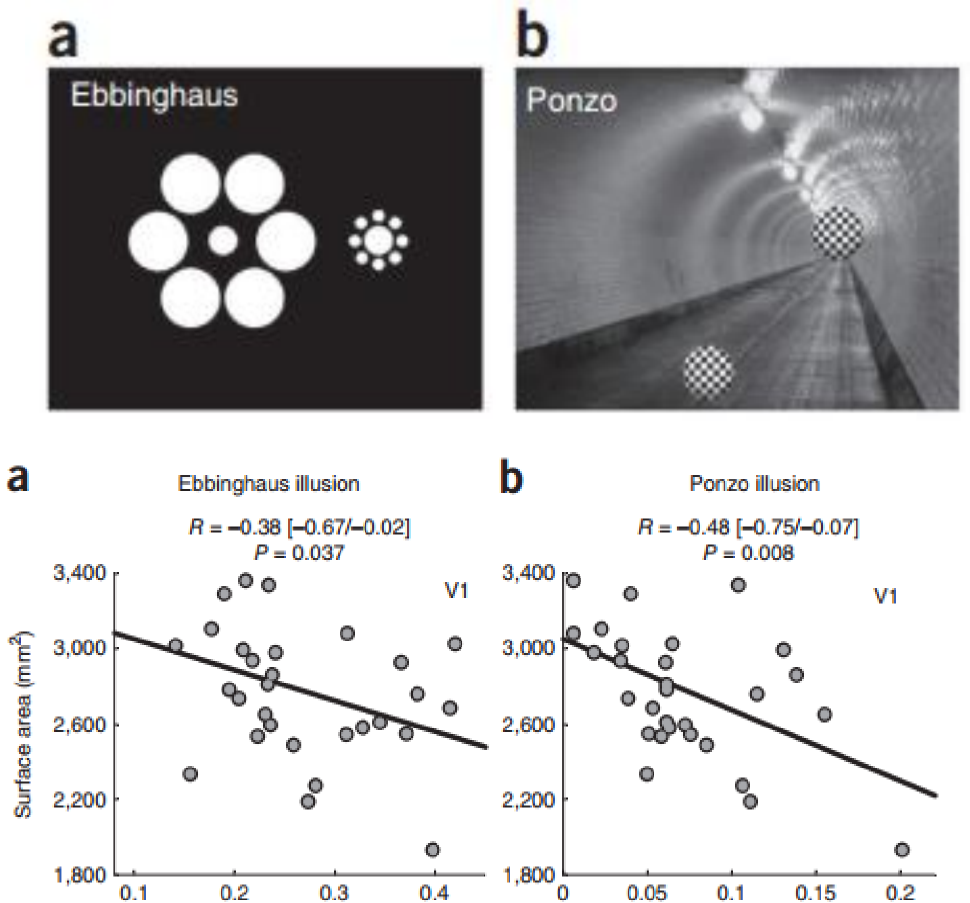
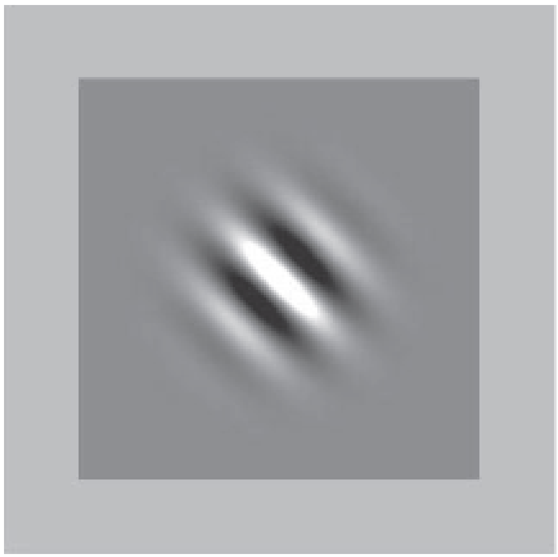
Test Validity

Illusions & V1 size

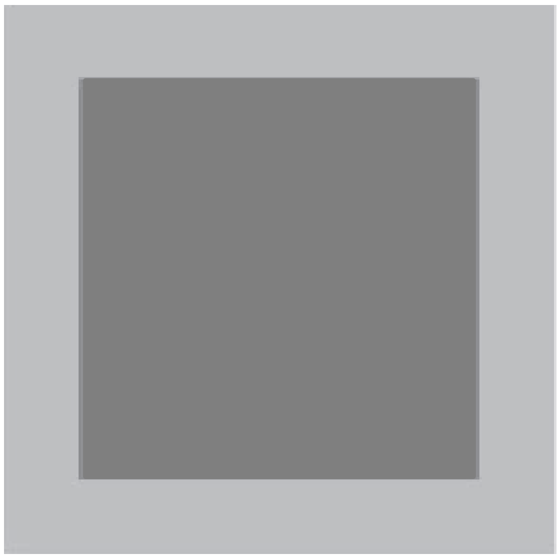


Schwartzkopf et al., 2011 (n = 30)

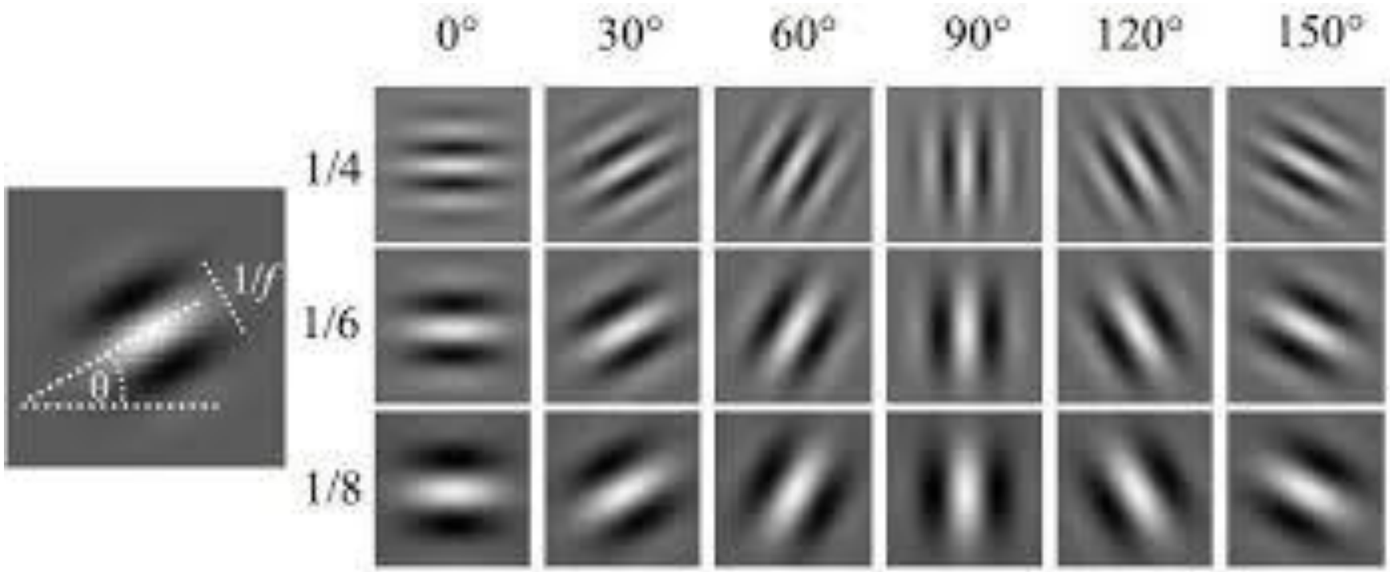
1. Tests



Contrast sensitivity

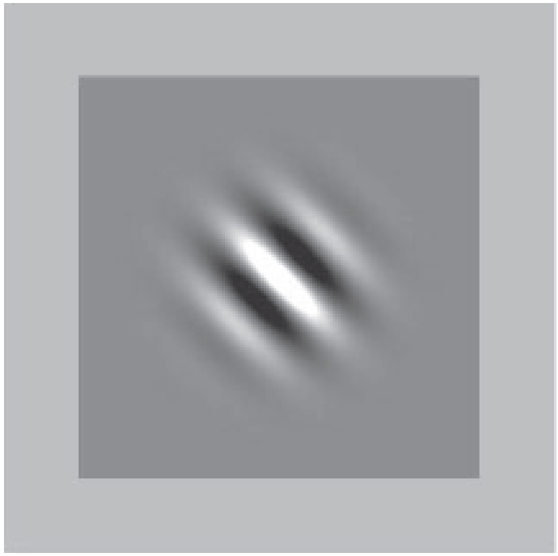


Contrast sensitivity



0°
30°
60°
90°
120°
150°
1/4
1/6
1/8
1/f
θ

Why this test? Significant result



Contrast sensitivity

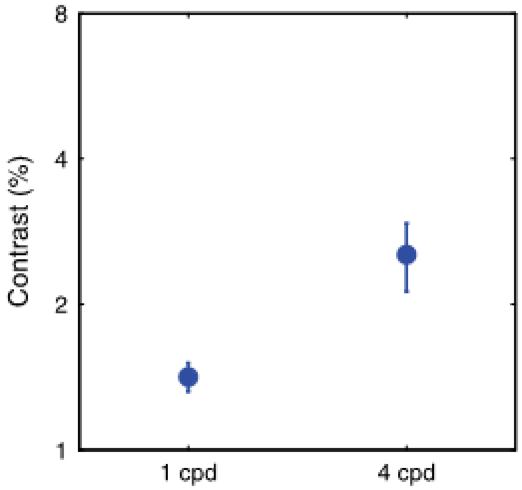
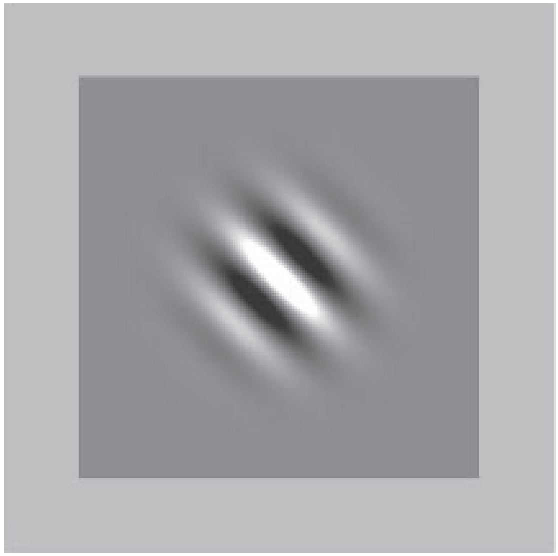


Figure 1. Contrast thresholds for older participants (red squares) and younger participants (blue circles) for 1 and 4 cpd Gabor patterns. Error bars represent ±1 *SEM* across 10 participants.

*Delahunt et al., 2008

Why this test? Significant result



Contrast sensitivity

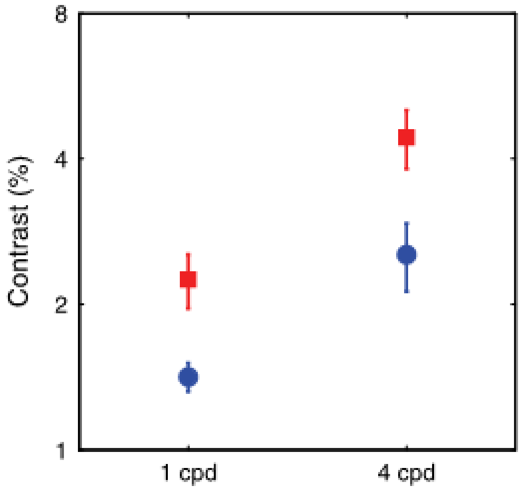
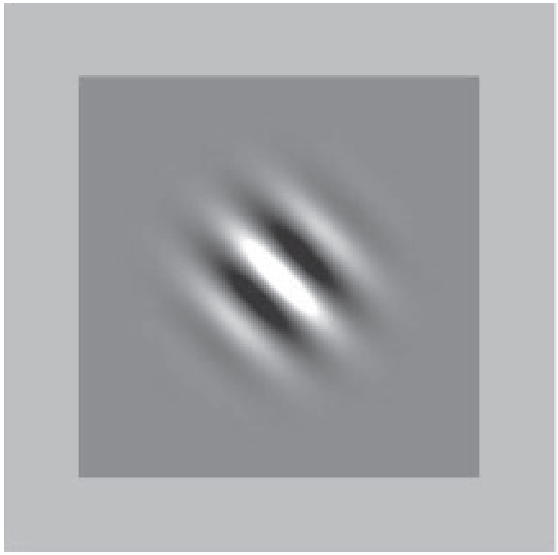


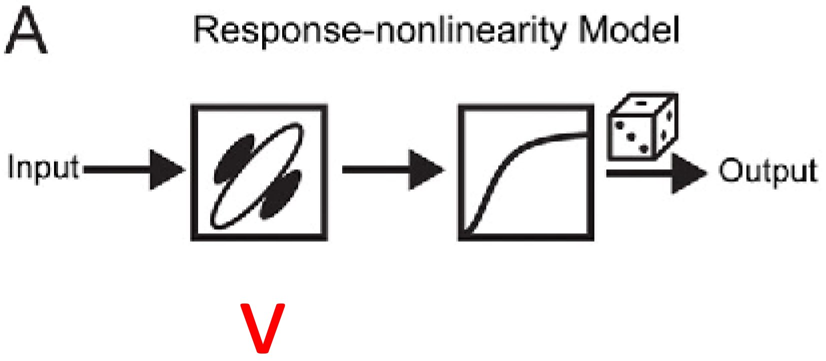
Figure 1. Contrast thresholds for older participants (red squares) and younger participants (blue circles) for 1 and 4 cpd Gabor patterns. Error bars represent ±1 *SEM* across 10 participants.

*Delahunt et al., 2008

One test is usually used



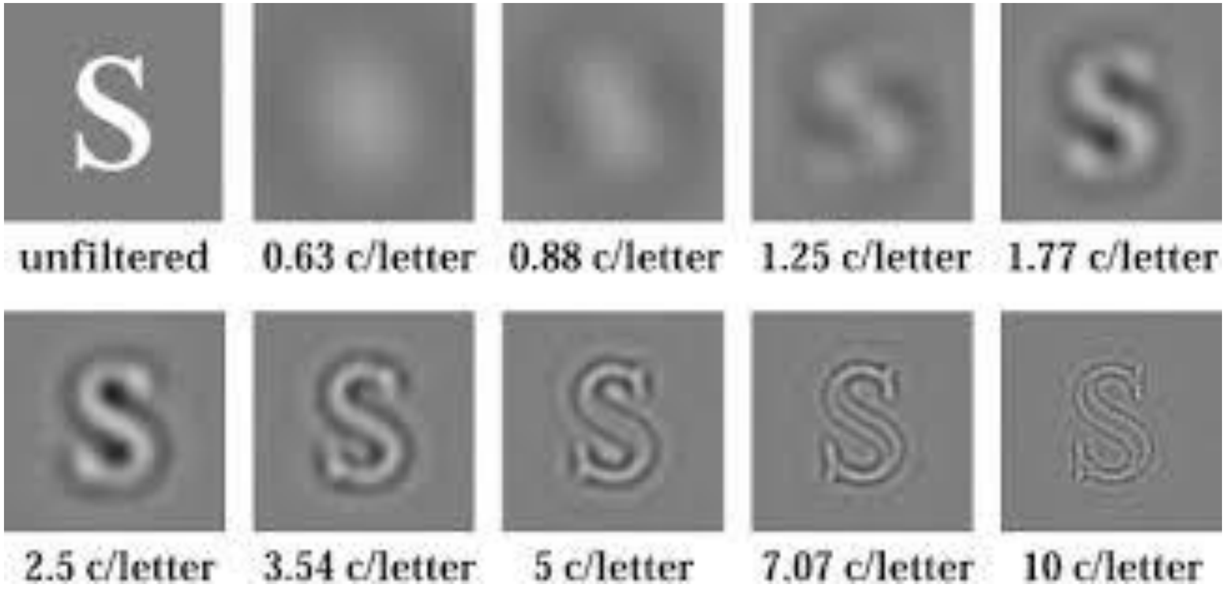
Contrast sensitivity



One test is sufficient because one mechanism/factor is at work

Why one test?

Similar tests do the same job and, hence, correlate with each other

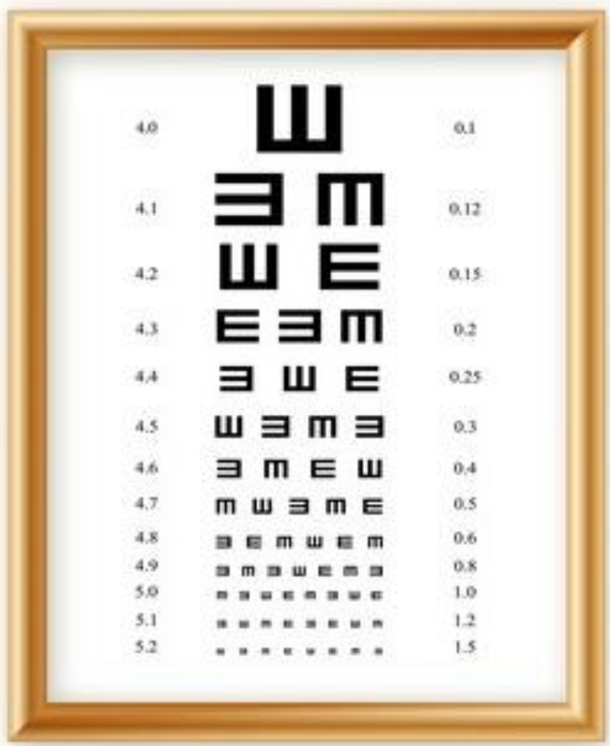


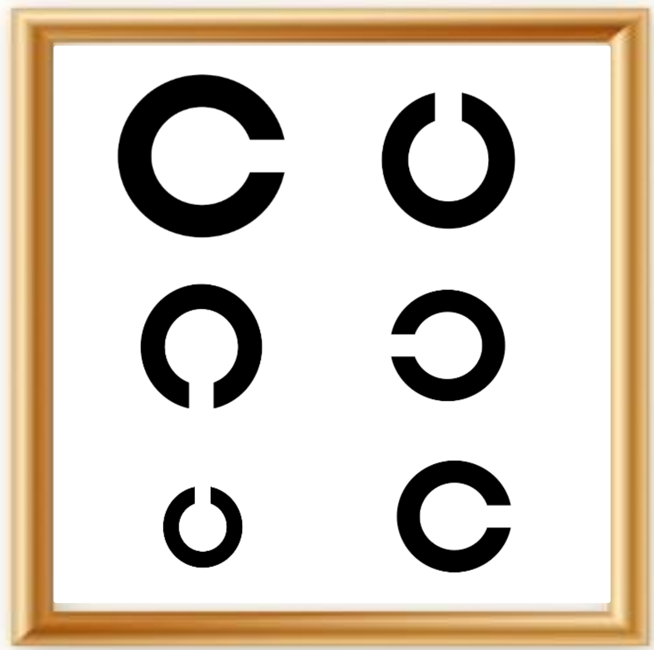
Assumptions

Why one test?
- One mechanism
- Similar tests do the same job and, hence, correlate with each other

Significance justifies use of test

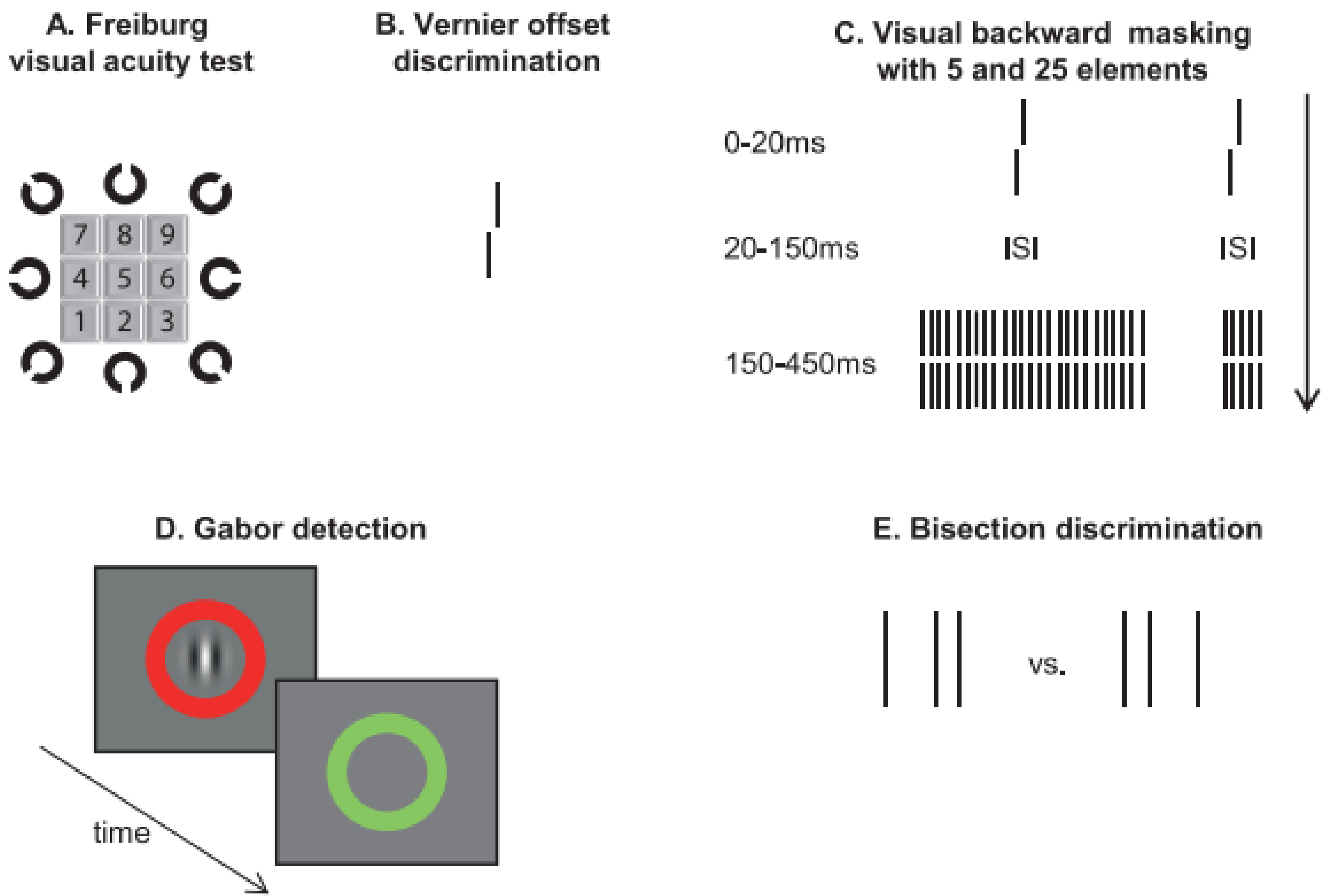
Tests are useless when they do not correlate with each other



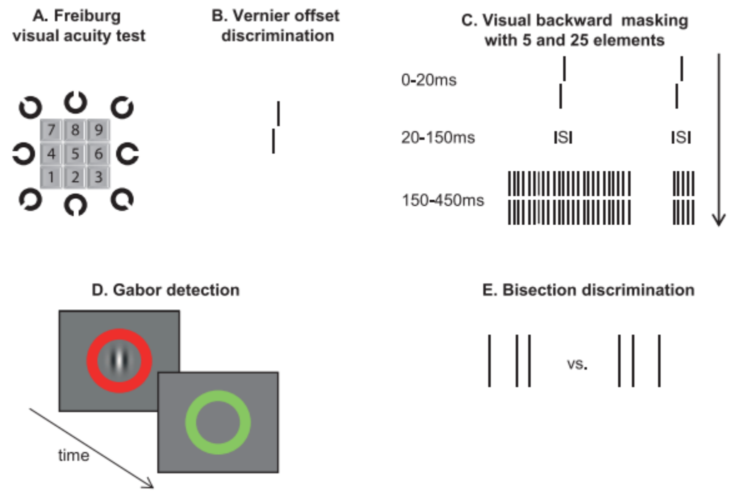


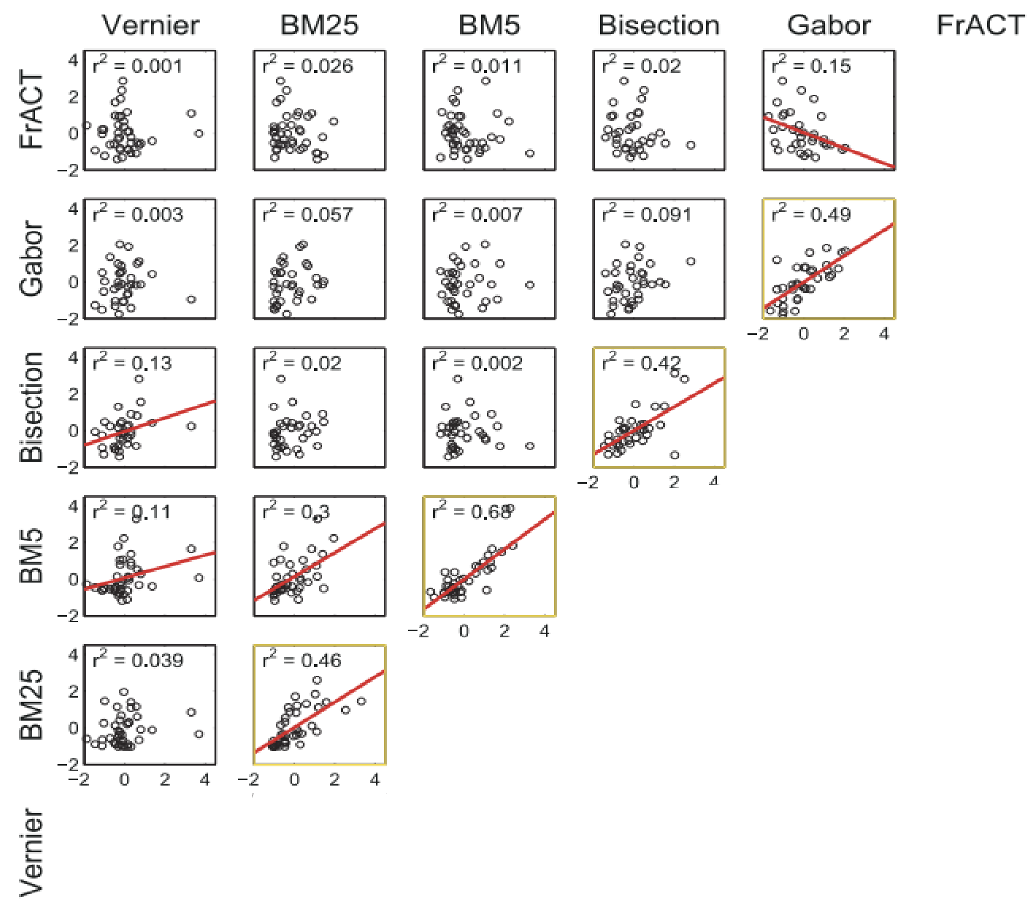
2. Vision tests do not correlate with each other

2.1. Spatial Tests



Cappe, C., Clarke, A., Mohr, C., & Herzog, M. H. (2014). Is there a common factor for vision? *Journal of Vision*.





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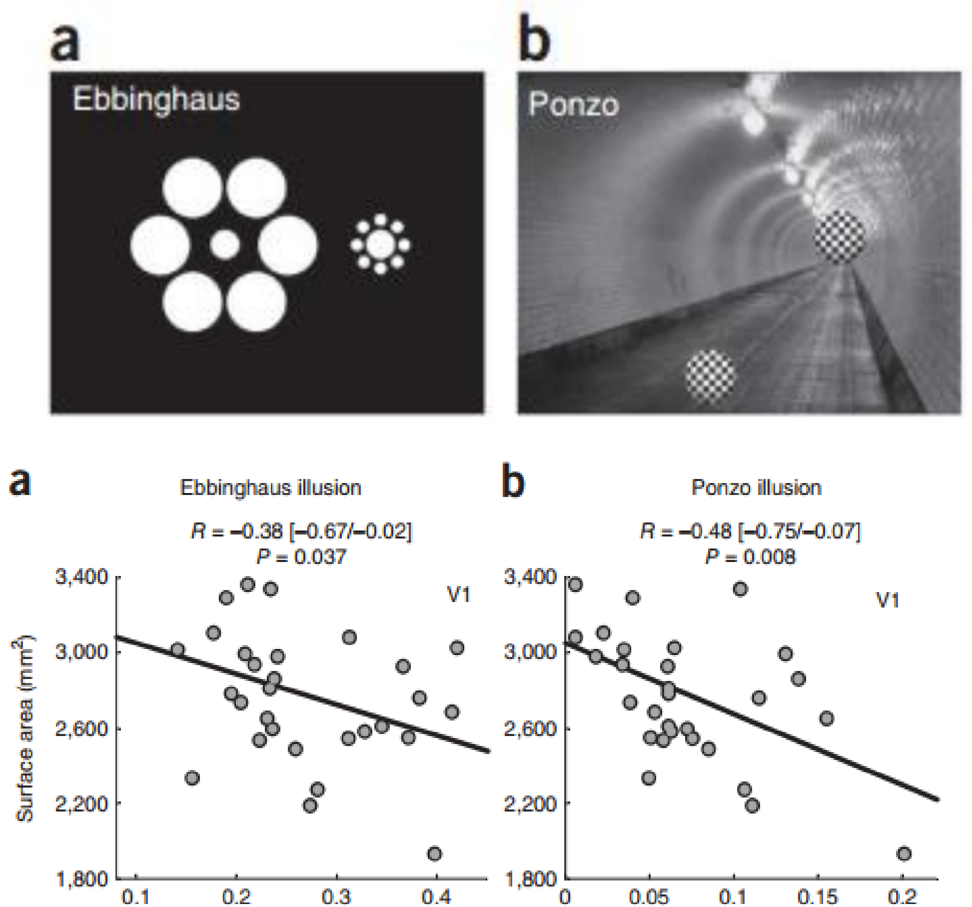
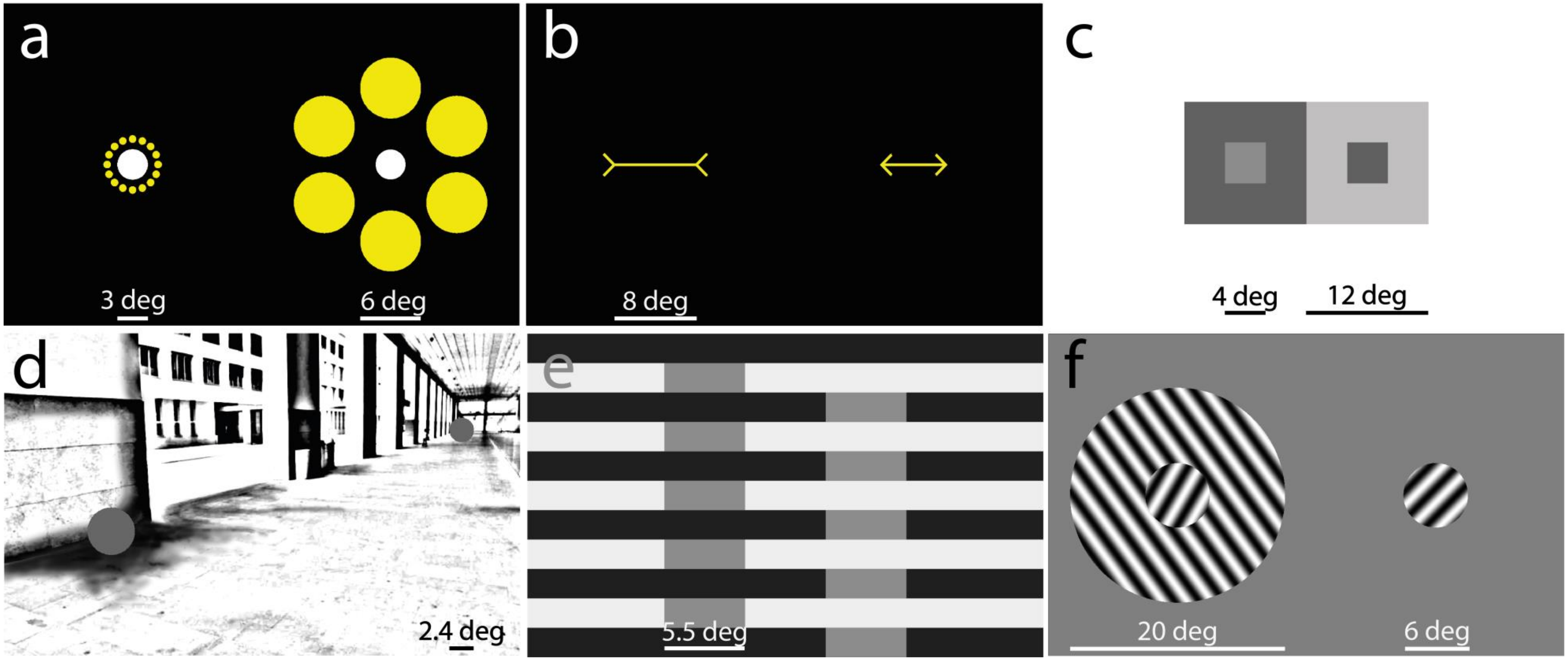
2.1. Spatial Illusions

Illusions & V1 size

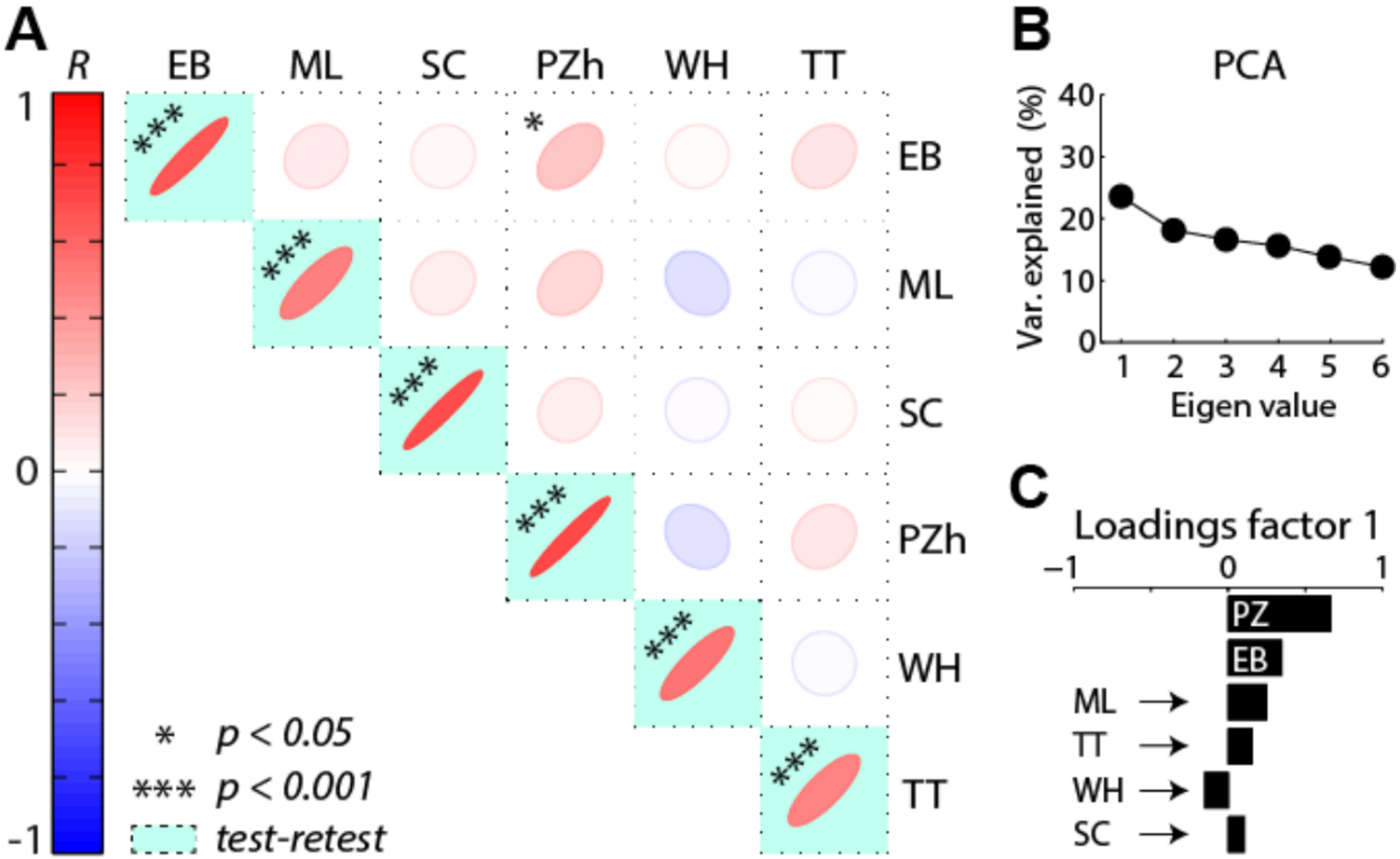


Schwartzkopf et al., 2011 (n = 30)

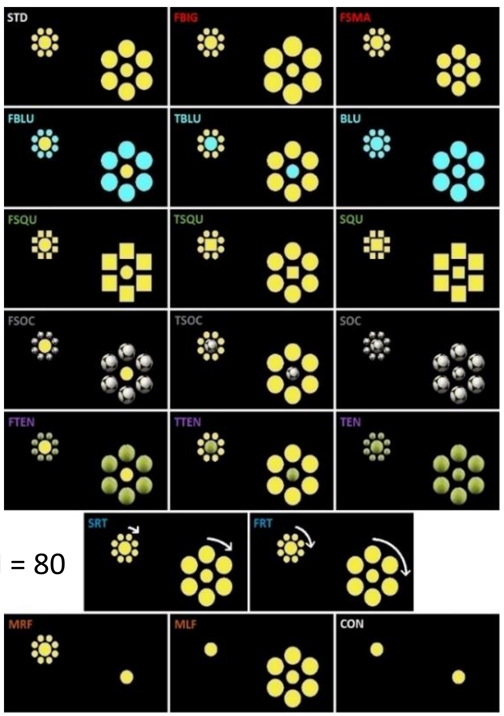
Illusions (n=144)



Illusions - correlations



Ebbinghaus factor



N = 80

	STD	FBIG FSM	A	FBLU	TBLU	BLU FSQ	U TSQ	U	SQU	FSOC TSO	C	SOC	FTEN	TTEN	TEN	SRT	FRT	MRF	MLF
STD	.59	.59	.52	.39	.56	.40	.41	.38	.39	.29	.34	.50	.43	.48	.29	.48	.44	.30	.23
FBIG	.93	.72	.50	.60	.63	.49	.50	.33	.59	.45	.37	.57	.55	.35	.43	.63	.56	.33	.36
FSMA	.96	.84	.50	.46	.54	.30	.34	.38	.57	.36	.42	.62	.52	.30	.49	.52	.49	.27	.38
FBLU	.65	.86	.81	.67	.63	.60	.36	.28	.45	.52	.39	.45	.58	.35	.30	.45	.48	.30	.34
TBLU	.98	.97	1	1	.60	.52	.53	.44	.53	.50	.52	.61	.59	.47	.43	.55	.55	.29	.35
BLU	.67	.73	.53	.95	.86	.63	.42	.30	.40	.49	.38	.41	.46	.43	.36	.47	.47	.24	.30
FSQU	1	1	.84	.71	1	.91	.44	.46	.39	.43	.42	.43	.51	.61	.41	.49	.47	.21	.14
TSQU	.72	.48	.74	.39	.76	.48	1	.59	.46	.36	.32	.46	.39	.45	.31	.33	.27	.25	.29
SQU	.74	1	1	.79	1	.72	.95	.89	.50	.45	.46	.65	.55	.41	.58	.51	.39	.40	.41
FSOC	.46	.63	.61	.77	.79	.75	.90	.56	.77	.68	.47	.40	.54	.29	.40	.58	.49	.18	.30
TSOC	.57	.51	.74	.56	.84	.57	.87	.48	.81	.71	.65	.58	.58	.47	.45	.48	.46	.37	.22
SOC	.89	.89	1	.70	1	.66	.95	.79	1	.63	.95	.60	.57	.50	.54	.54	.50	.33	.25
FTEN	.79	.86	1	.94	1	.76	1	.63	1	.87	.97	.99	.60	.51	.53	.55	.53	.27	.31
TTEN	.86	.52	.55	.54	.81	.71	1	.78	.76	.43	.77	.87	.90	.58	.49	.40	.49	.31	.16
TEN	.61	.69	1	.44	.78	.63	.85	.44	1	.68	.76	1	.97	.93	.60	.53	.42	.23	.40
SRT	.82	.96	.97	.69	.93	.76	1	.53	.94	.91	.76	.92	.96	.66	1	.61	.76	.10	.37
QRT	.76	.83	.88	.72	.90	.74	1	.37	.68	.75	.69	.81	.87	.82	.70	1	.65	.15	.24
MRF	.56	.49	.51	.44	.46	.37	.32	.35	.76	.24	.59	.54	.40	.51	.26	.10	.15	.57	.16
MLF	.38	.52	.69	.51	.55	.47	.23	.46	.73	.44	.31	.39	.49	.22	.71	.59	.35	.22	.63

→ EFA suggested 1 factor explaining ~44%

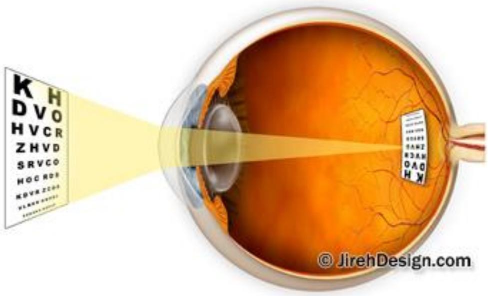
Cretenoud, A. F., Karimpur, H., Grzeczkowski, L., Francis, G., Hamburger, K., & Herzog, M. H. (2019). Factors underlying visual illusions are illusion-specific but not feature-specific. Journal of Vision, 19(14):12, 1–21.

2.3. Ageing

Healthy aging

Level of the eye:

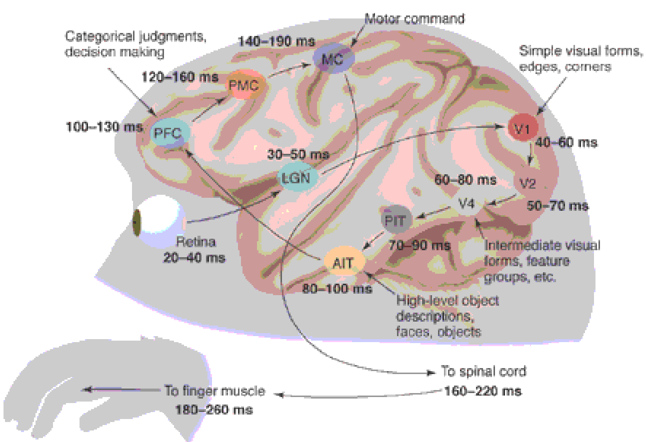
Optics, retinal mosaic, etc.



Visual cortex:

GABA, neuron density, etc.

General Slowing down



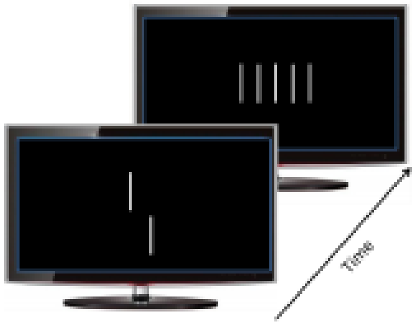
Methodology

Participants:

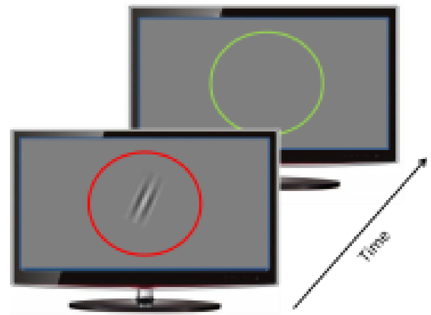
Group	Old	Young
Participants	131 (73 Males) 96 with MoCa>26	108 (48 Males) 106 kept
Age	69.8 Years Old (sd 6.76)	21.8 Years old (sd 2.69)
Recruited	TCS (driving tests/course) + Tbilisi, Georgia	EPFL (students) + Tbilisi, Georgia

Perceptual tests

Vernier acuity & backward masking

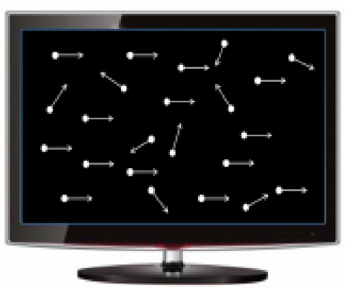


Contrast sensitivity (Gabors)

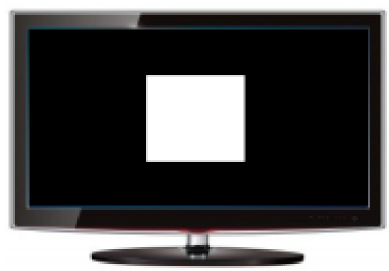


Biological motion perception

Motion direction discrimination



Simple RT Task

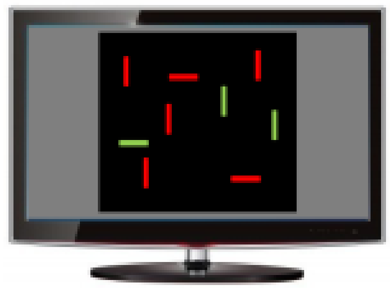


Orientation discrimination

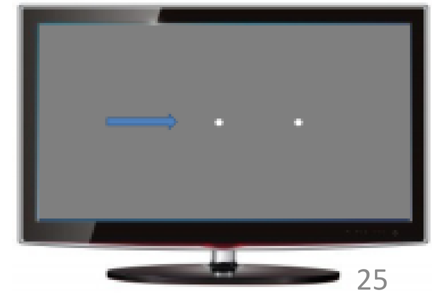
Visual Acuity

Audiothreshold and pitch

Visual Search Task



Visual Simon Task

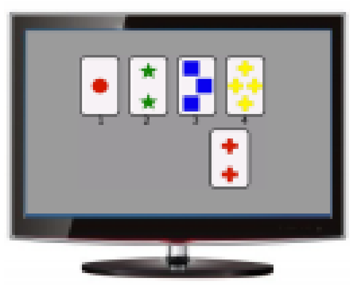


Cognitive tests and questionnaires

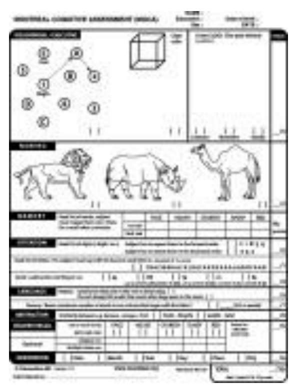
Digit Span forward and backward

Fluency

Wisconsin Card Sorting Test



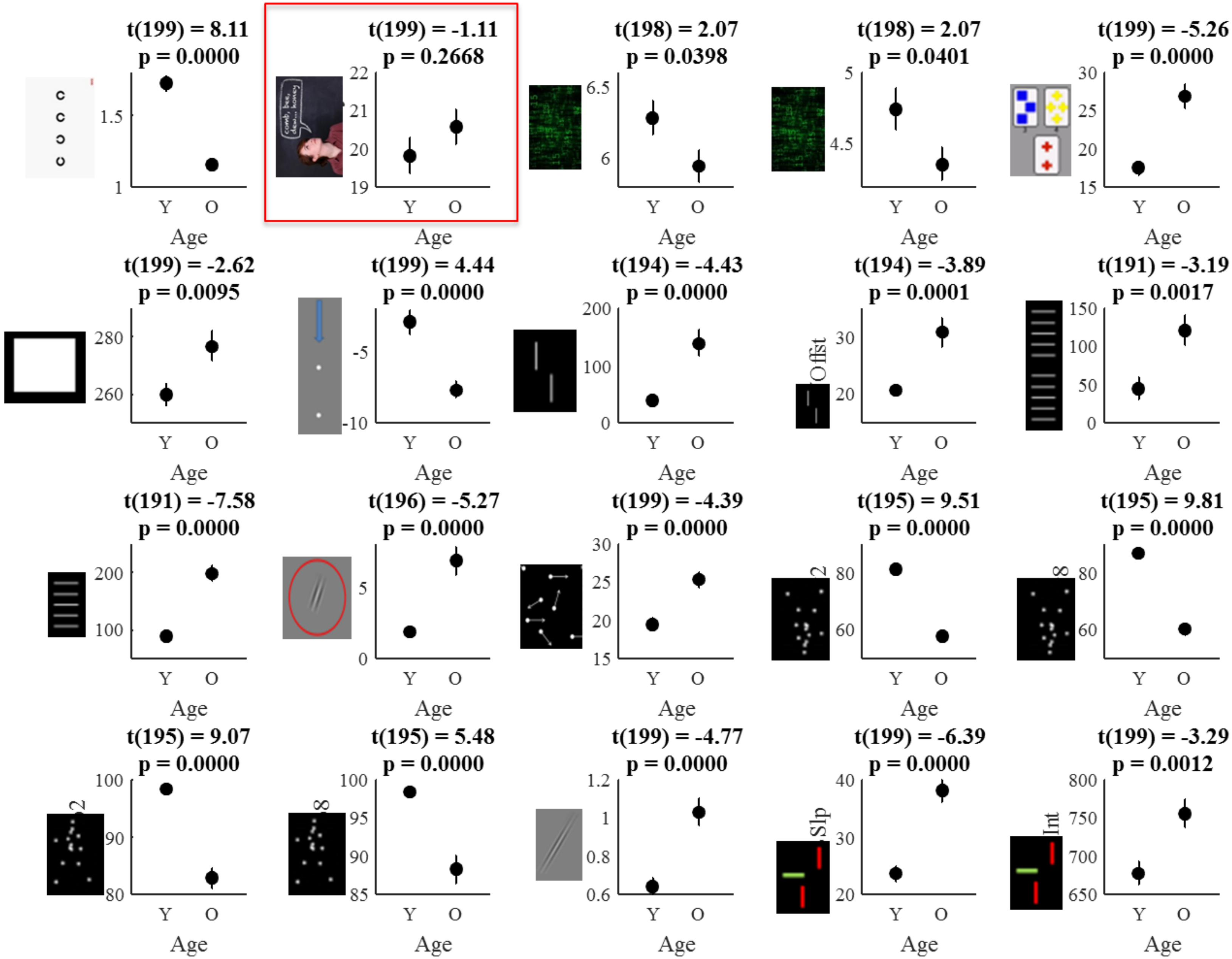
MoCa



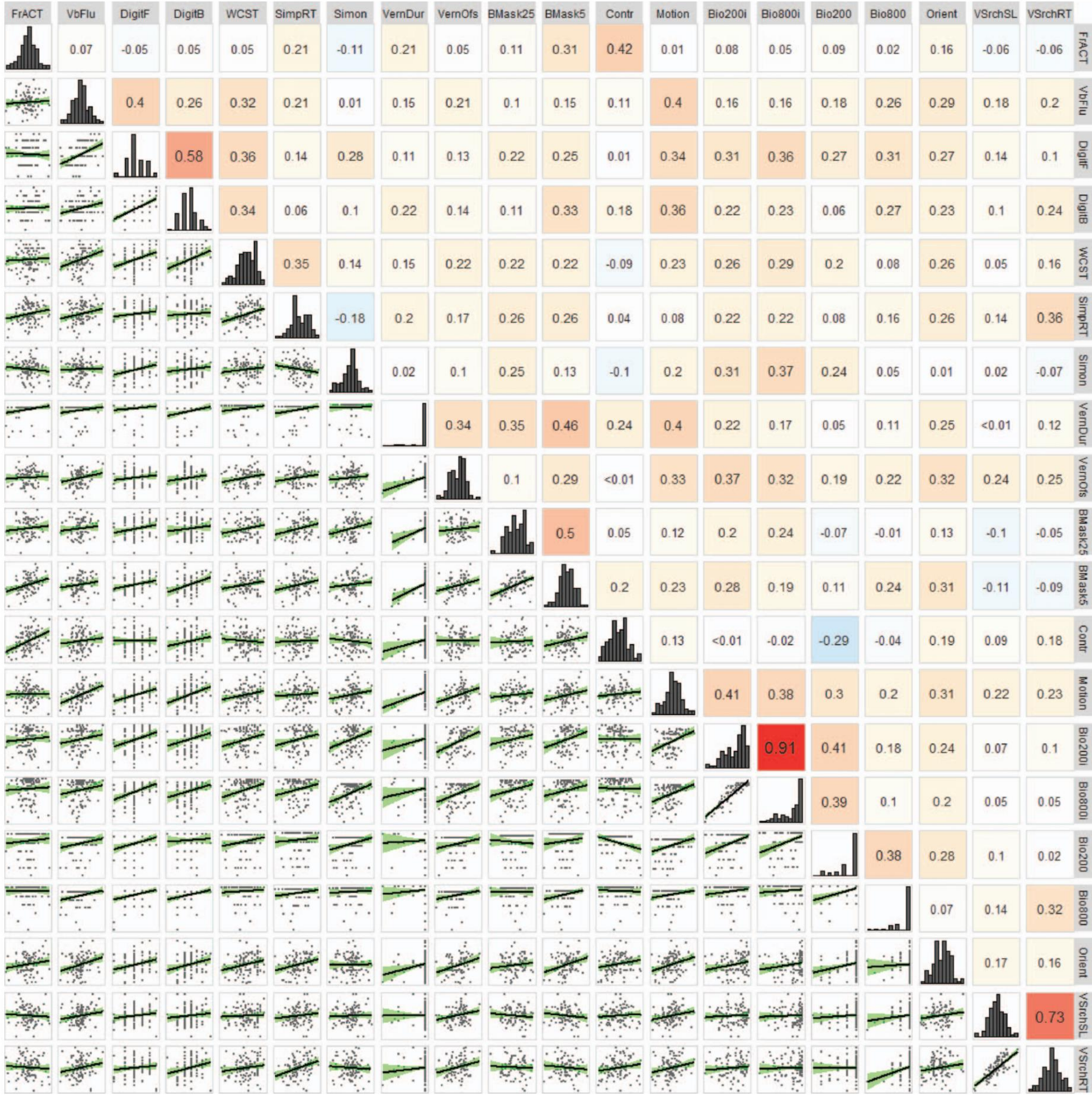
Questionnaires:

1. General information
2. International physical ability
3. Autism quotient
4. Morning-evening questionnaire
5. Geriatric depression scale

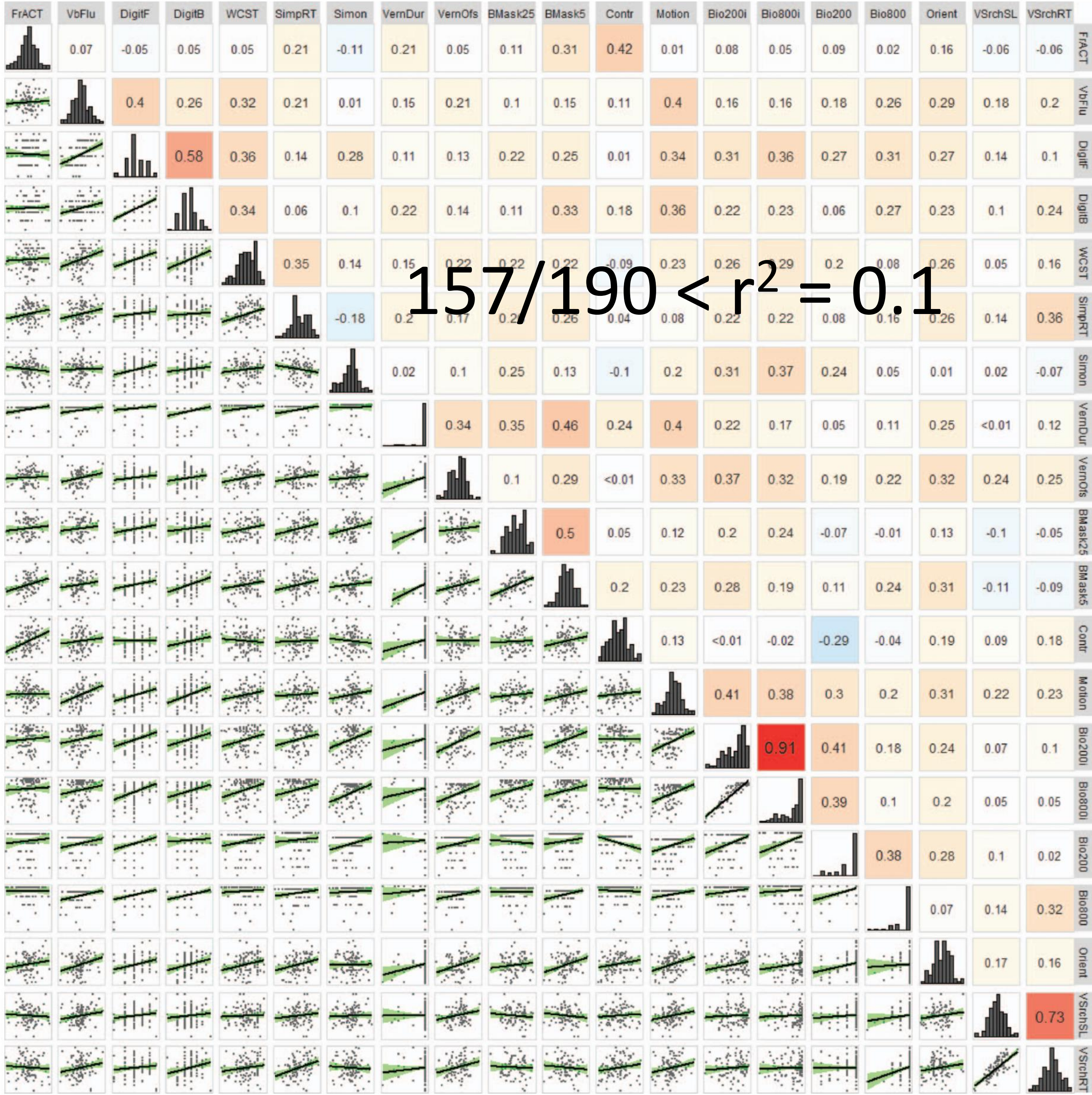
Differences young-old in all tests



Correlations: young participants

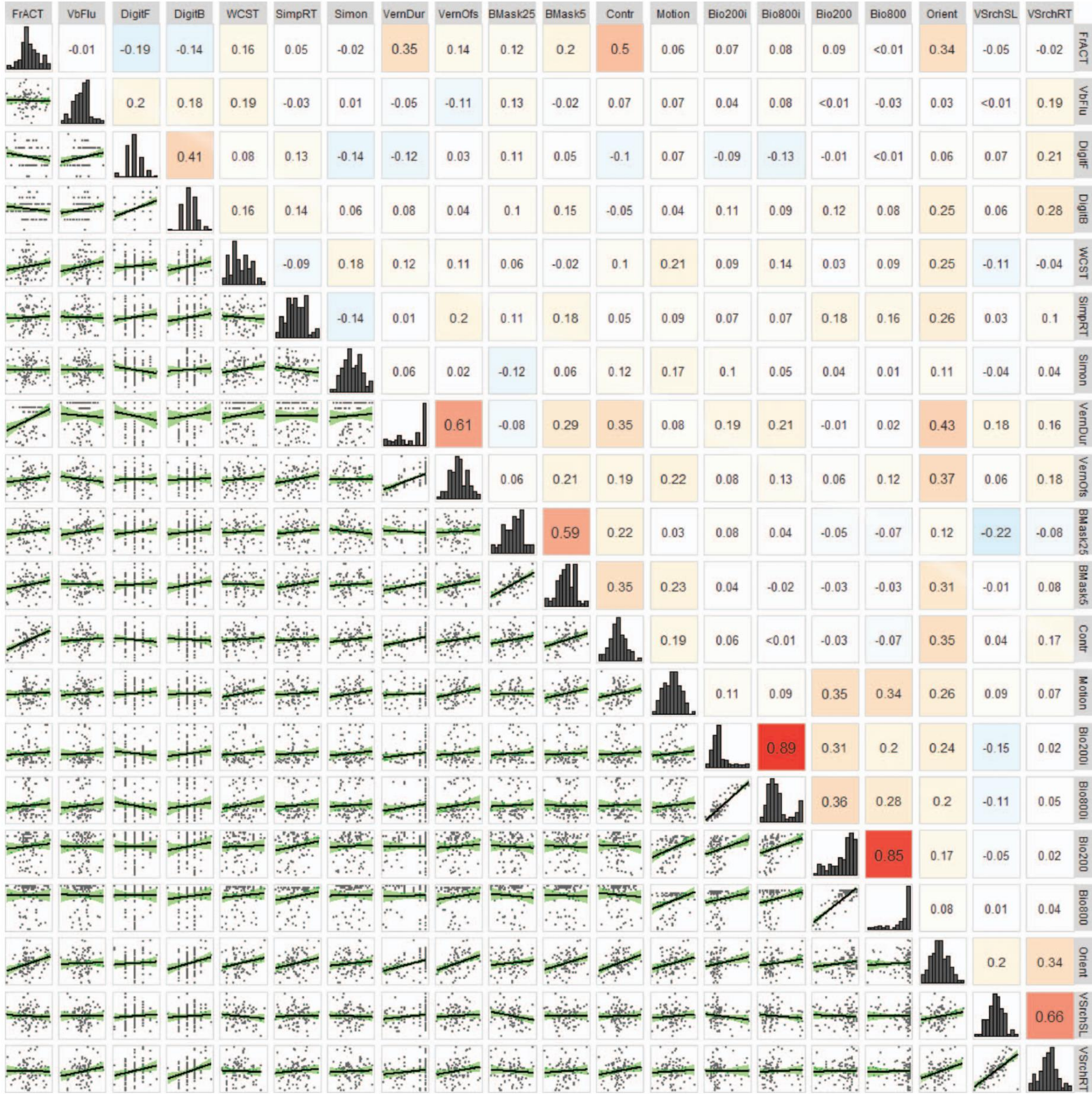


Correlations: young participants

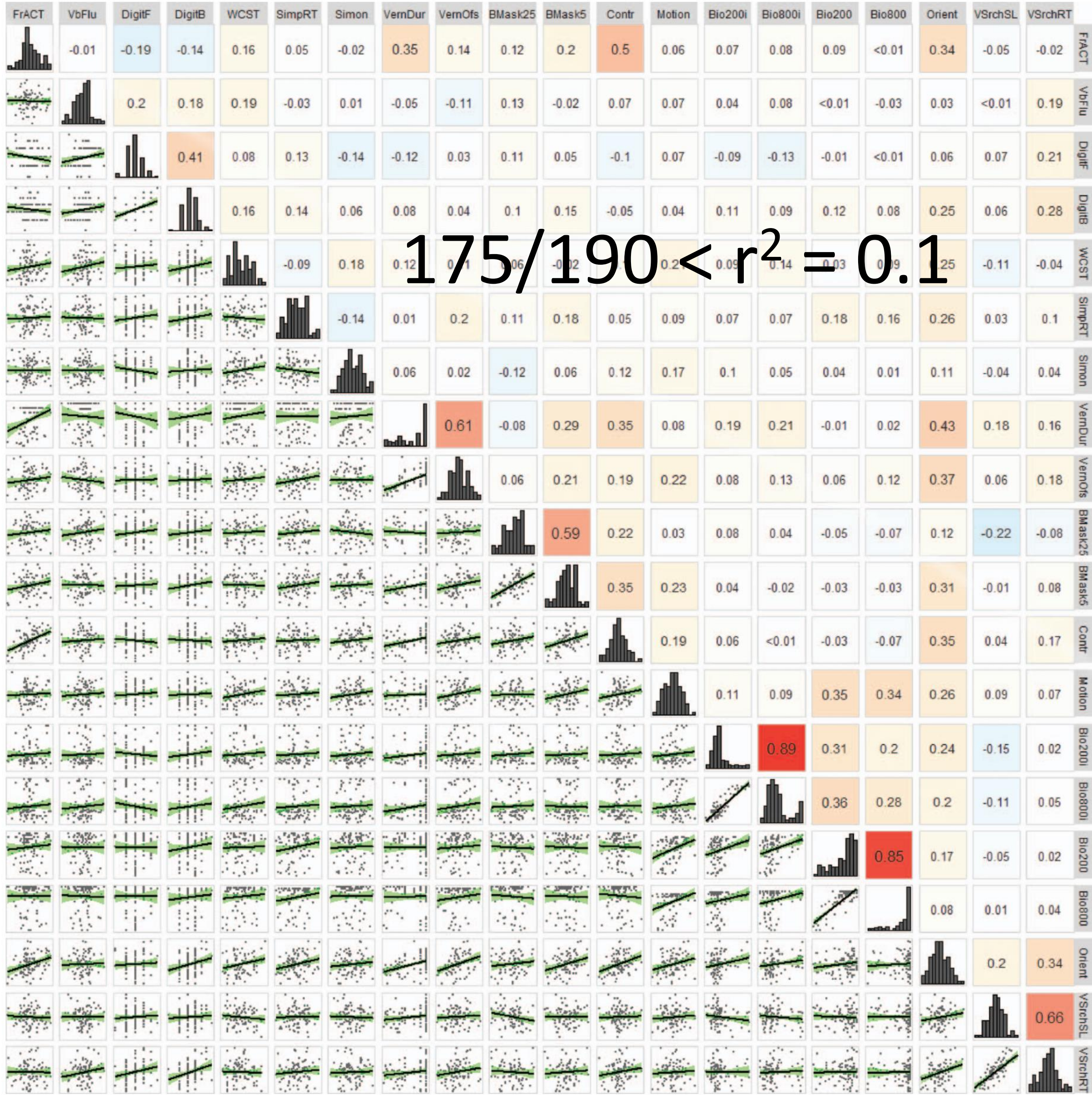


157/190 < $r^2 = 0.1$

Correlations: older participants



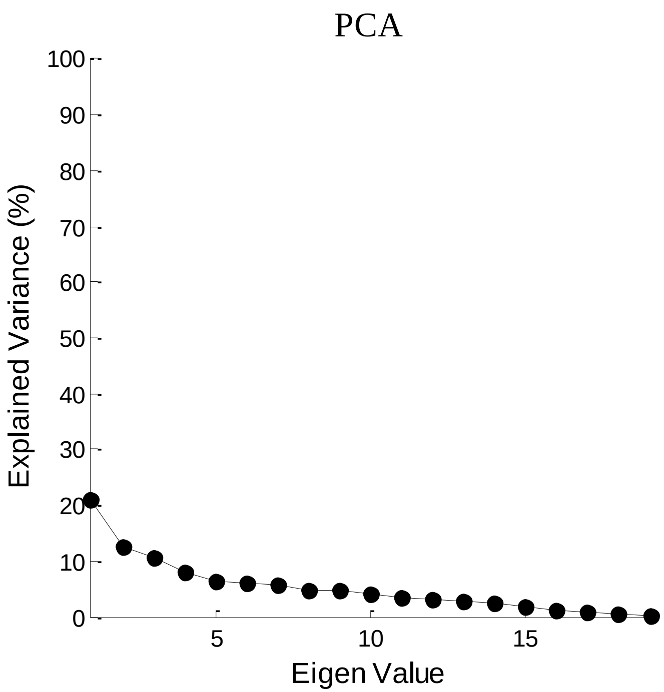
Correlations: older participants



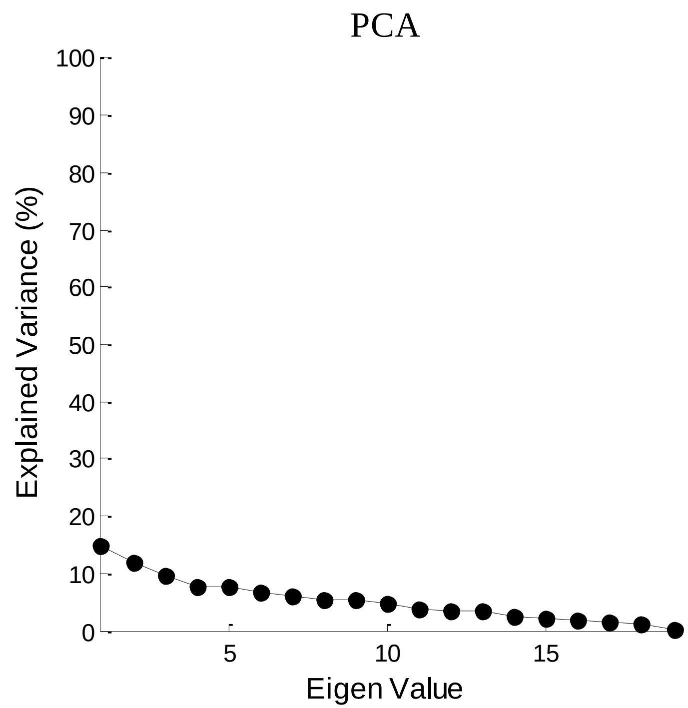
Correlations: older participants

PCA/Factor analysis

Young



Old



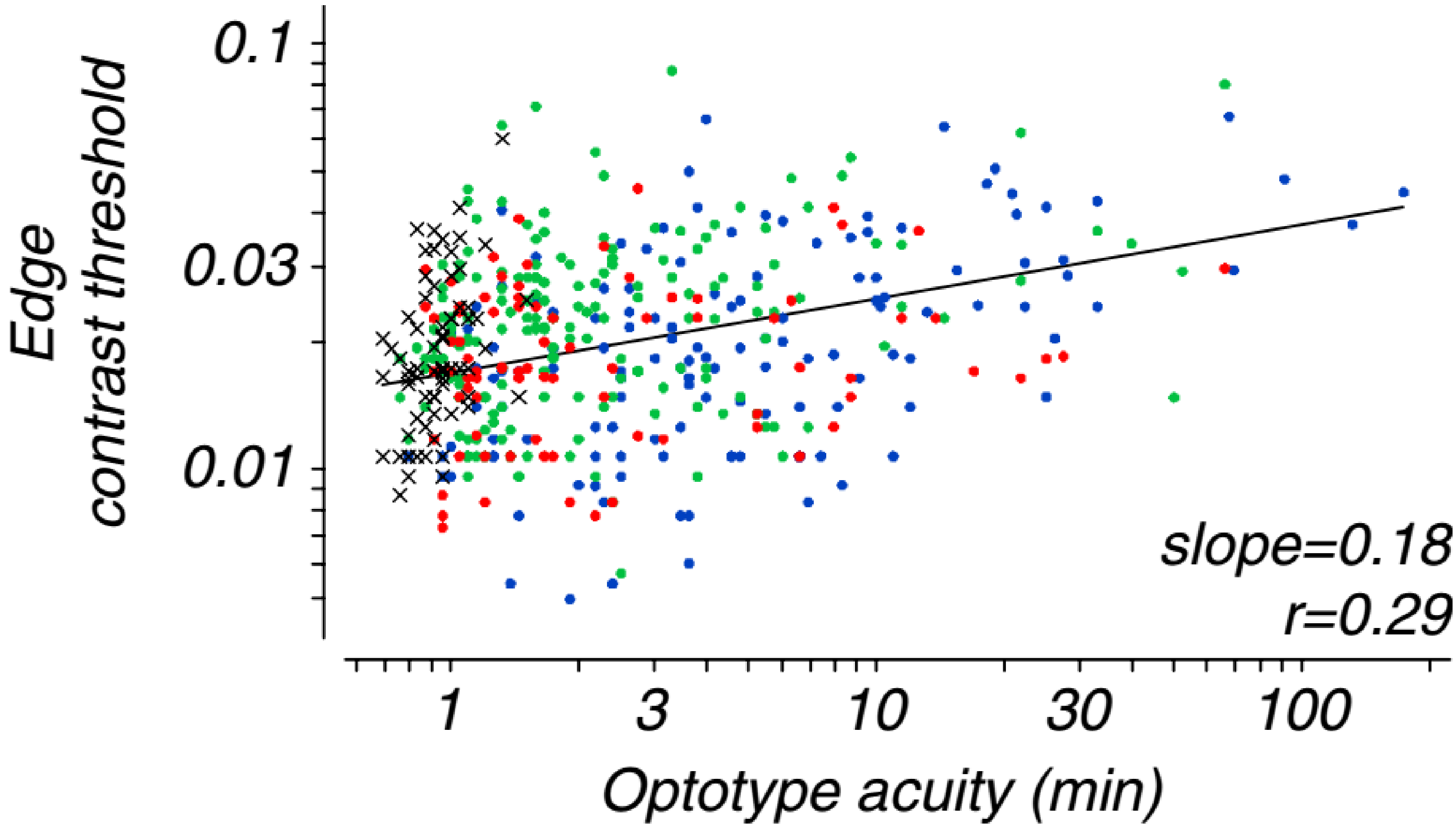
Hence, each task is a "factor" and each factor ages individually

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

VELUX STIFTUNG
Charitable Foundation supporting Research about Daylight, Healthy Aging and Ophthalmology.

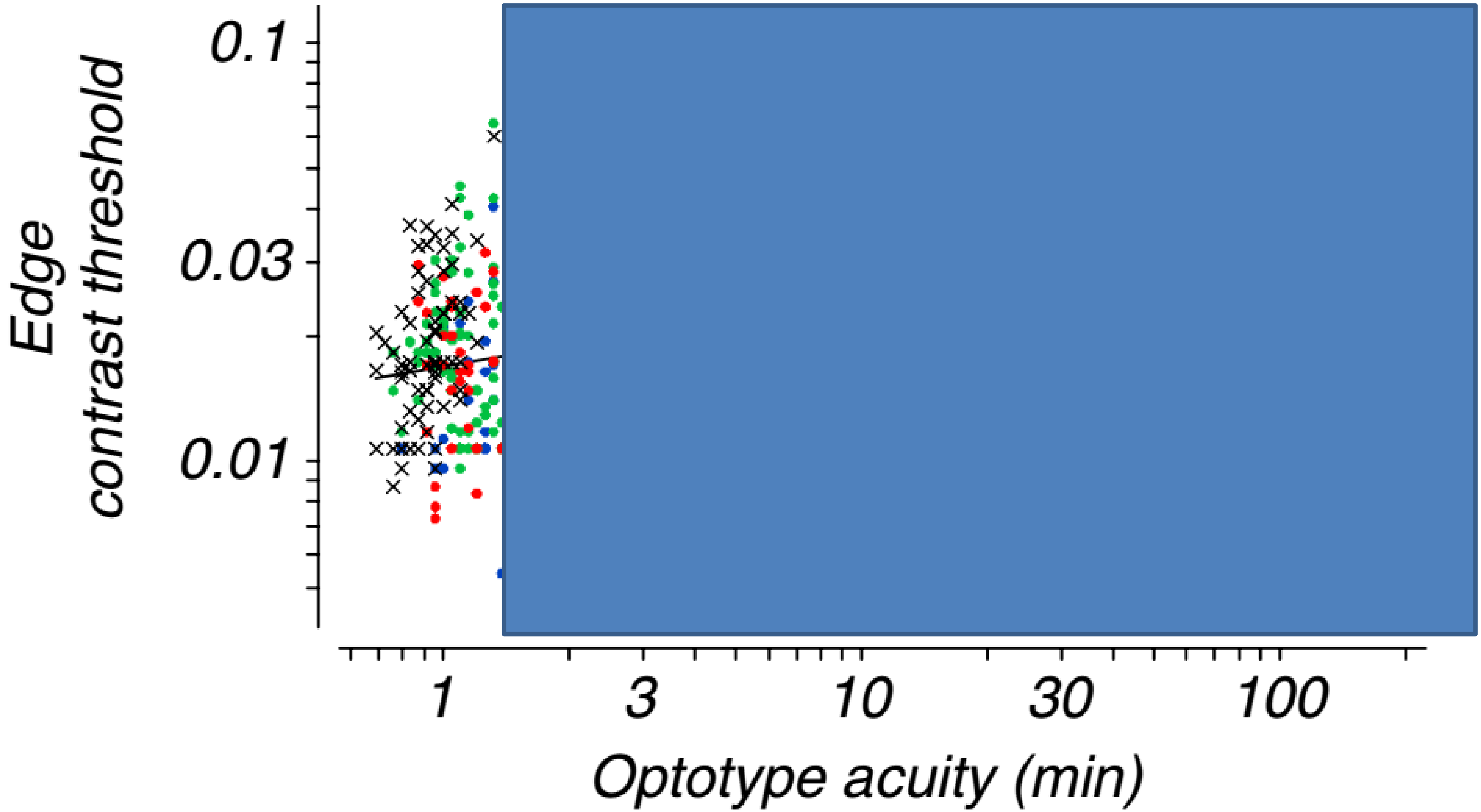
Important: Healthy Ageing

Reminder: Healthy aging



McKee, Levi, Movshon, 2003

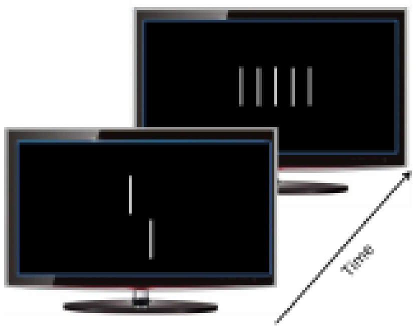
Reminder: Healthy aging



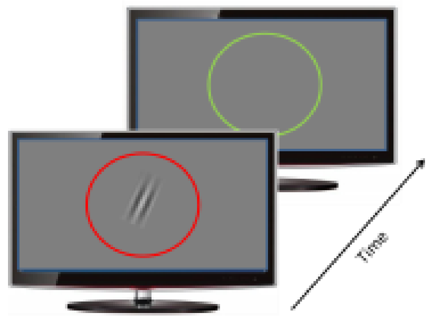
Aren’t there older people with better perception than others?

Aren’t there older people with better perception than others?

Vernier acuity & backward masking

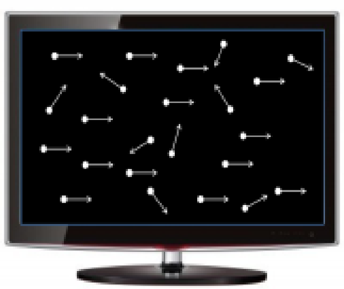


Contrast sensitivity (Gabors)

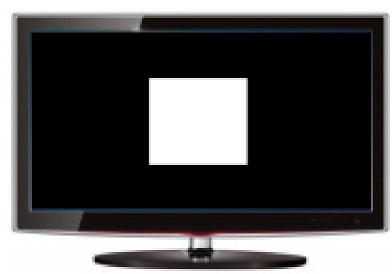


Biological motion perception

Motion direction discrimination



Simple RT Task

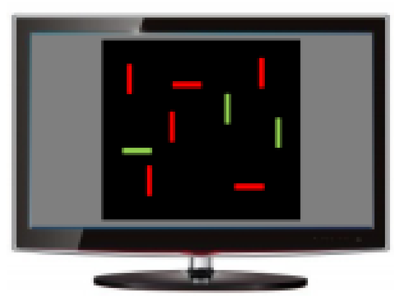


Orientation discrimination

Visual Acuity

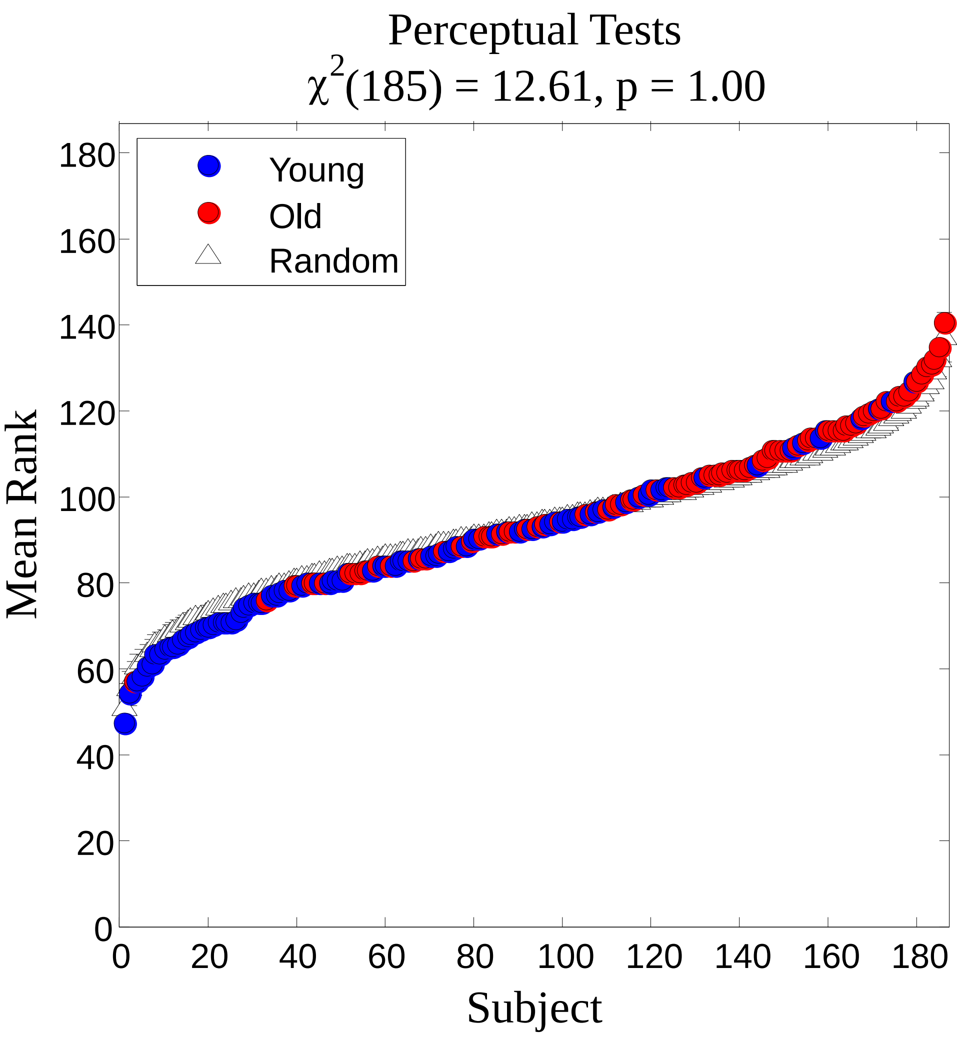
Audiothreshold and pitch

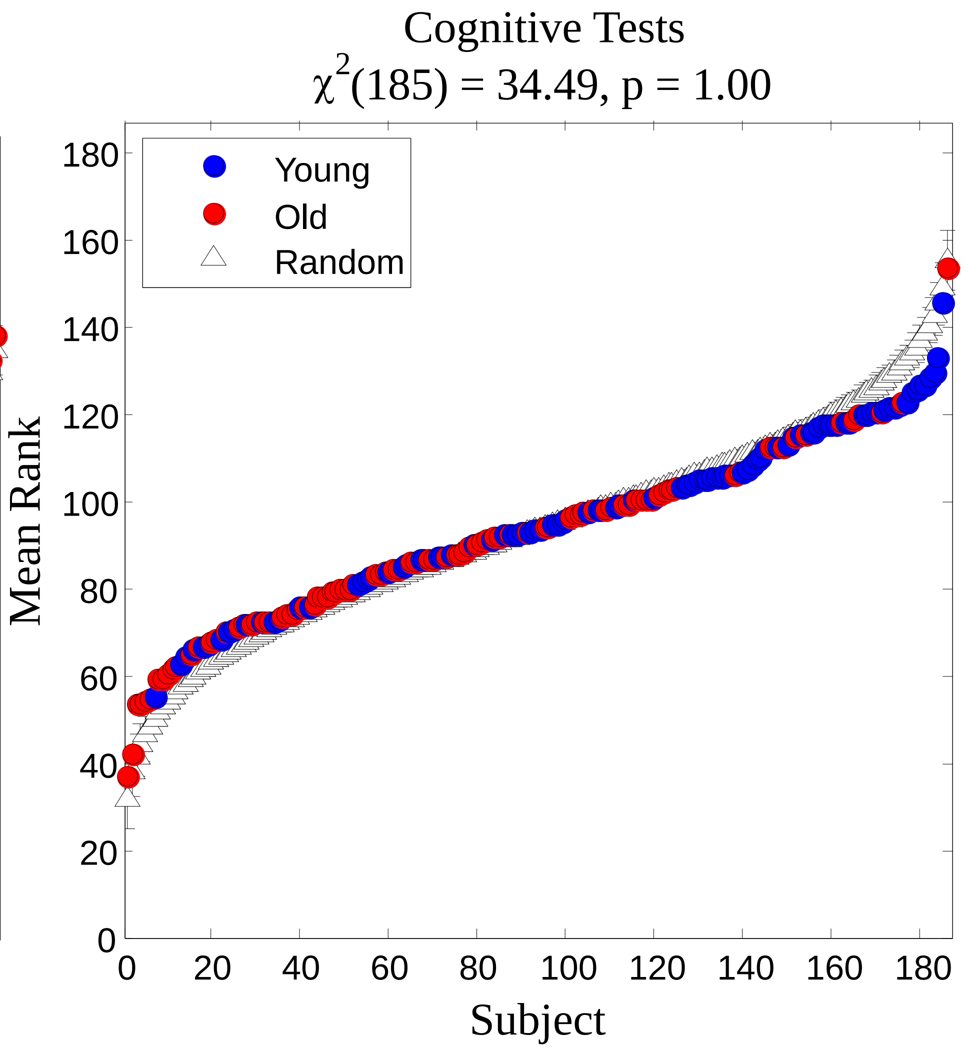
Visual Search Task



Visual Simon Task

Ranking analysis

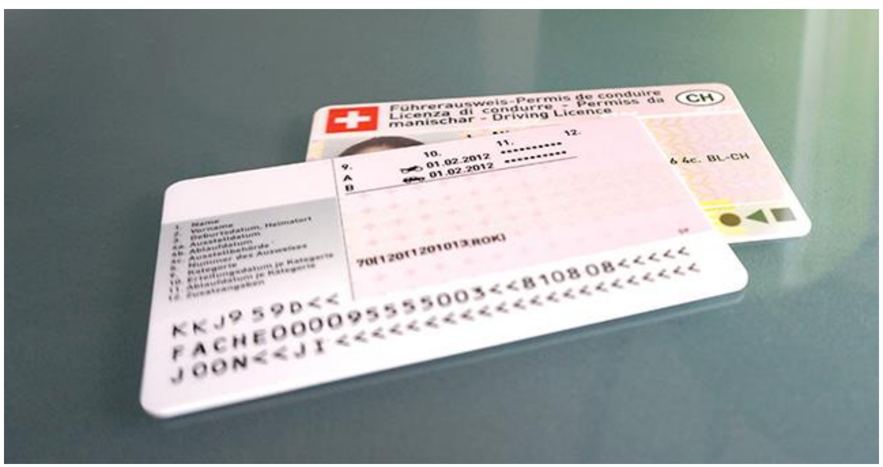




Aren’t there older people with better perception?

Yes they are better- but not differently than expected by a random selection of “individual” ageing factors for each task

2.4. Driving



	On-road driving score [0-8]			Driving restriction score [0-20]		
	Coefficient	R^2	p-value*	Coefficient	R^2	p-value*
Visual processing - spatial components						
Spatial sensitivity threshold (0.1 logMAR)	0.191	0.049	0.115	0.096	0.007	0.556
Contrast sensitivity threshold (0.1 log(CS))	0.045	0.010	0.492	0.104	0.029	0.229
Orientation discrimination threshold (arcmin)	0.333	0.051	0.108	0.107	0.003	0.702
Vernier offset (pixels)	0.074†	0.156	0.004	0.044	0.031	0.215
Visual processing - temporal components						
Vernier masking task						
Vernier duration (100ms)	0.049	0.001	0.808	0.183	0.010	0.490
SOA5 (100ms)	0.250	0.031	0.215	0.661†	0.122	0.011
SOA25 (100ms)	0.041	< 0.001	0.838	0.380	0.041	0.151
UFOV‡ (level of risk [0-5])	0.558†	0.175	0.003	0.392	0.054	0.128
Visual processing (100ms)	3.249†	0.222	0.001	2.419	0.077	0.059
Divided attention (100ms)	0.113	0.007	0.579	0.308	0.032	0.231
Divided attention (100ms)	0.367	0.080	0.053	0.160	0.010	0.513
Visual recognition task‡ (score [0 – 1])	2.203	0.058	0.104	1.939	0.028	0.260
Central visual processing [ln(ms)]	0.362	0.044	0.085	0.366	0.041	0.171
Peripheral visual processing [ln(ms)]	0.265	0.036	0.202	0.165	0.009	0.532
Dual tasking [ln(ms)]	0.391	0.018	0.367	0.968	0.070	0.073
Visual processing - motion detection						
Motion direction threshold (%)	0.015	0.007	0.547	0.023	0.009	0.504
Biological motion (%)	0.002	0.001	0.830	0.011	0.008	0.522
Visual processing - executive function						
Simple response time (100ms)	-0.739	0.021	0.303	-0.746	0.012	0.434
Simon's effect (Δt in ms)	-0.033	0.017	0.358	0.071	0.045	0.131
Trail Making Test‡ Part A (10 sec)	-0.111	0.021	0.332	-0.076	0.006	0.596
Visual search (ln[ms])	0.509	0.012	0.435	1.404	0.053	0.101

3. Why?

There are two aspects

A methods issue: how we do science- currently

An ontological issue: what do data tell about the world

3a. Why? Poor Tests?

Why not! Not a matter of….

- Power (with n~200; effect size of d=0.03 detectable

- Test-retest-reliability (which is usually good)

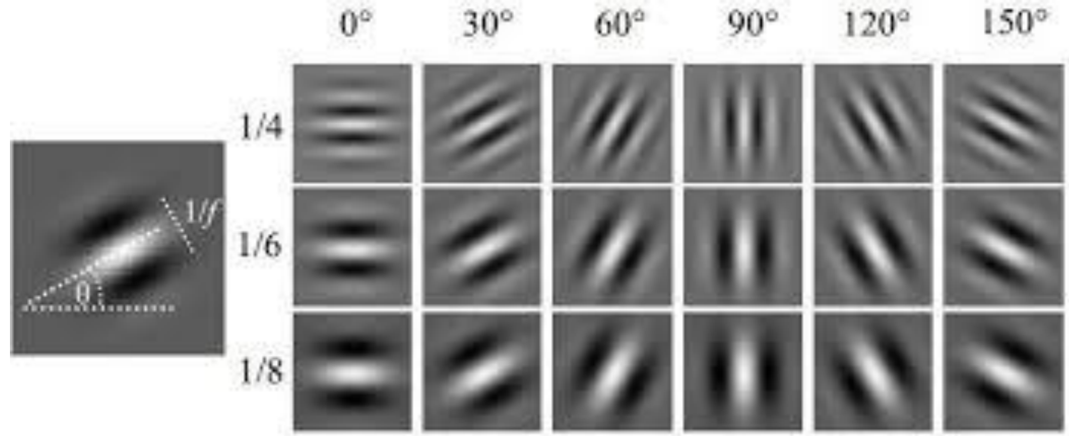
- Reliability paradox (variance is large)

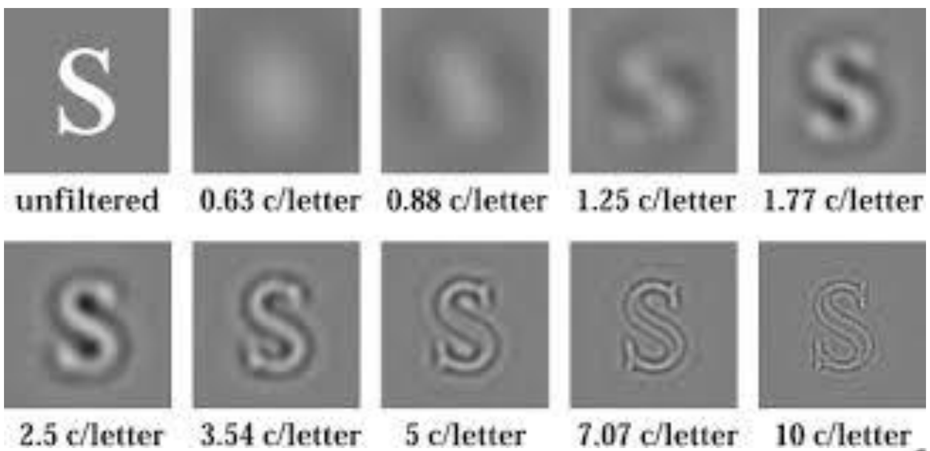
- Linear methods (non-linear methods yield same results)

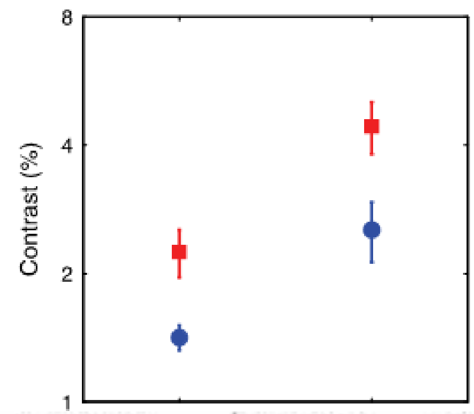
3b. Why? Idiosyncratic tests?

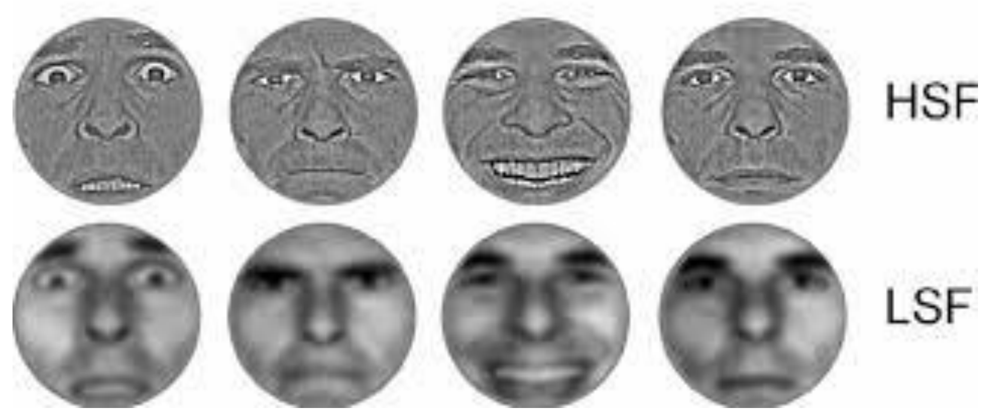
or

Latent construct does not exist


0°
30°
60°
90°
120°
150°
1/4
1/6
1/8
1/f
θ

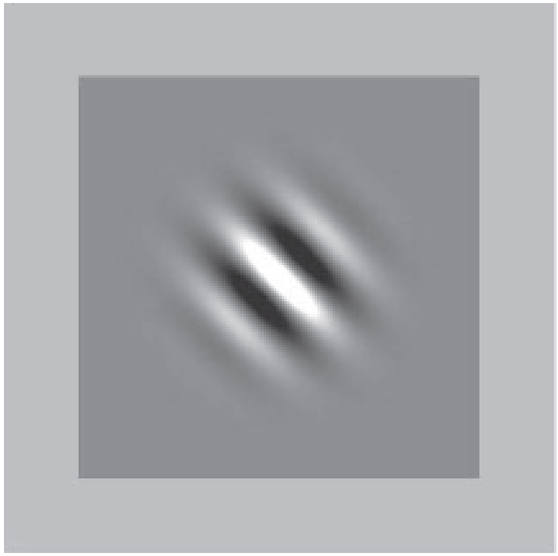

S
unfiltered
0.63 c/letter
0.88 c/letter
1.25 c/letter
1.77 c/letter
2.5 c/letter
3.54 c/letter
5 c/letter
7.07 c/letter
10 c/letter


Contrast (%)
8
4
2
1


HSF
LSF

3c. Why?
Mono-factoriality and significance

Wait…we got significance



Contrast sensitivity

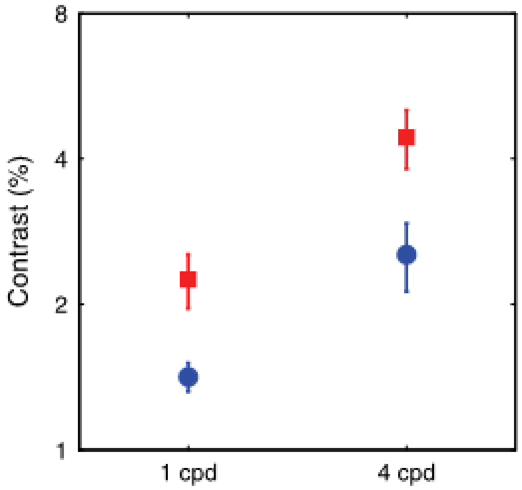
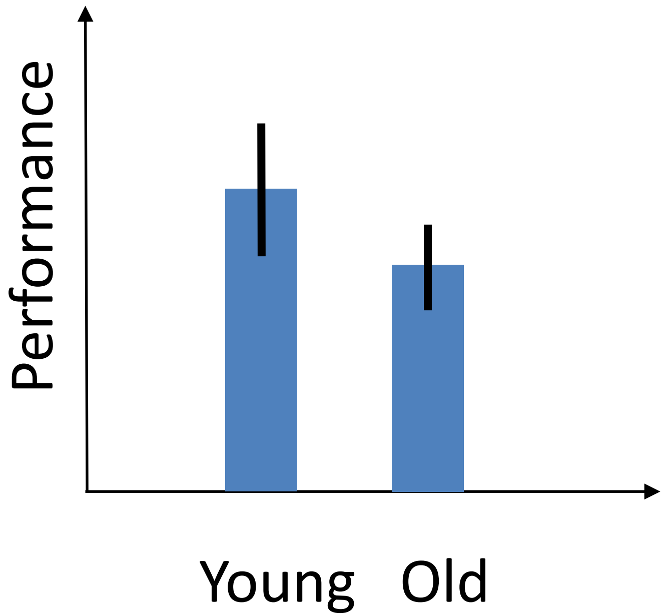


Figure 1. Contrast thresholds for older participants (red squares) and younger participants (blue circles) for 1 and 4 cpd Gabor patterns. Error bars represent ±1 *SEM* across 10 participants.

*Delahunt et al., 2008

Significance is not a good justification for the selection of a test

Cohen's d



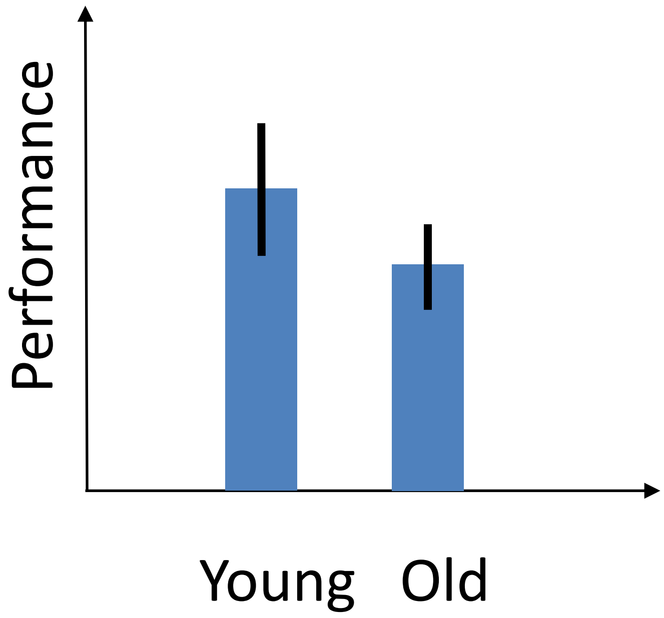
$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$

d = 0.2 small effect
d = 0.5 medium effect
d = 0.8 large effect

d = 0.8 = 65% discriminability
d ~ 4 = 99% discriminability

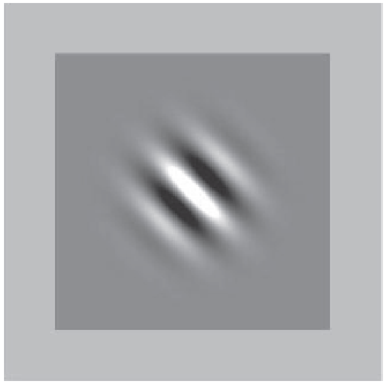
Male vs Female d~1.4
Most d in science < 0.5

Cohen's d



$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$

$x_{ij} = v_i + e_{ij}$

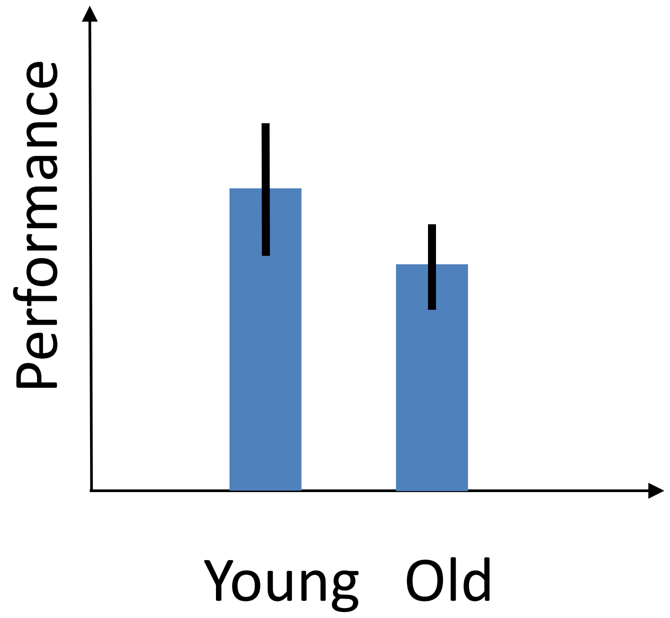


v_i: inter-participant variability

e_{ij}: measurement noise

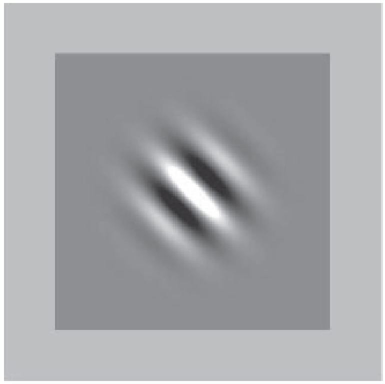
for trial j for subject i

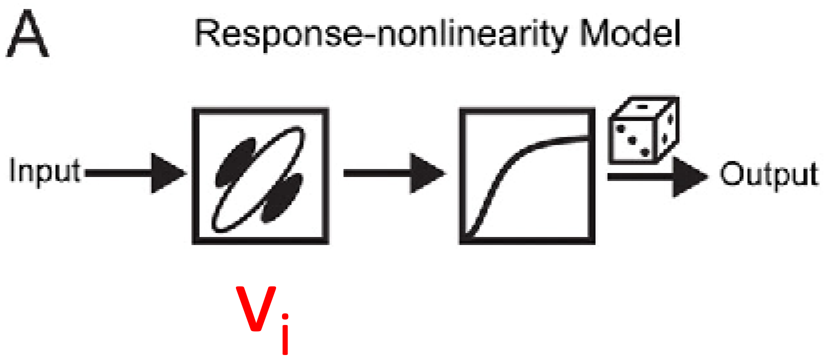
Cohen's d



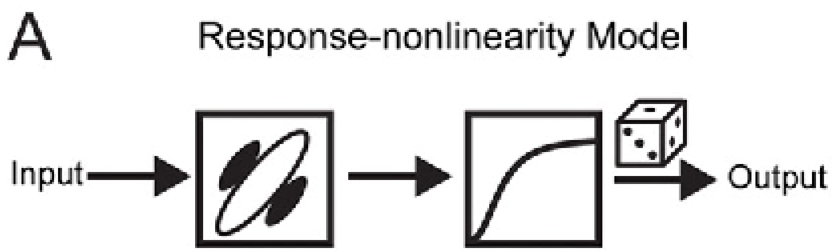
$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$

$$x_{ij} = v_i + e_{ij}$$





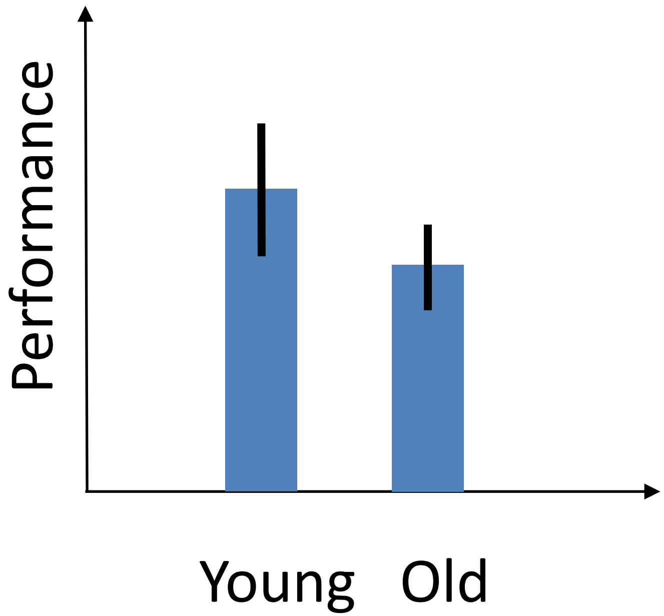
Let us look through a microscope:



Lousy microscope paradox

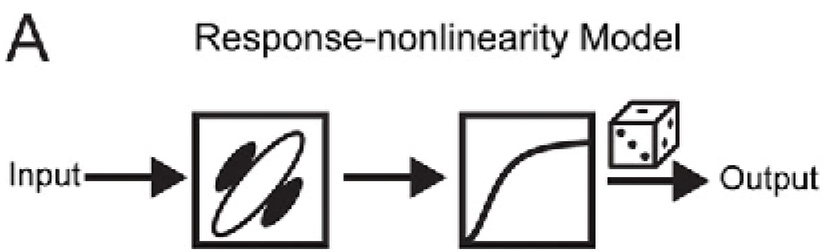
Significant result
Cohen's d = 0.8
Same sample size

Cohen's d



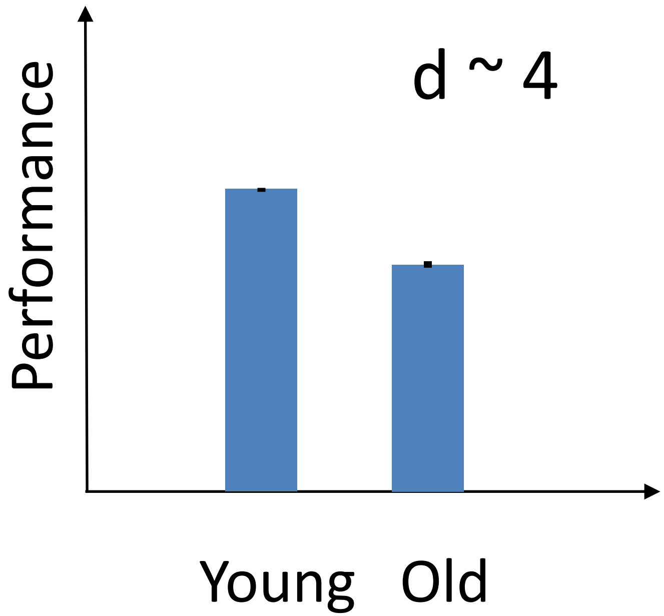
$$x_{ij} = v_i + e_{ij}$$

$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$



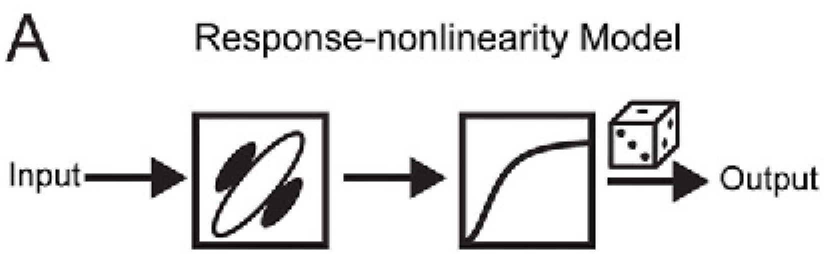
d = 0.8 << 4

Cohen's d

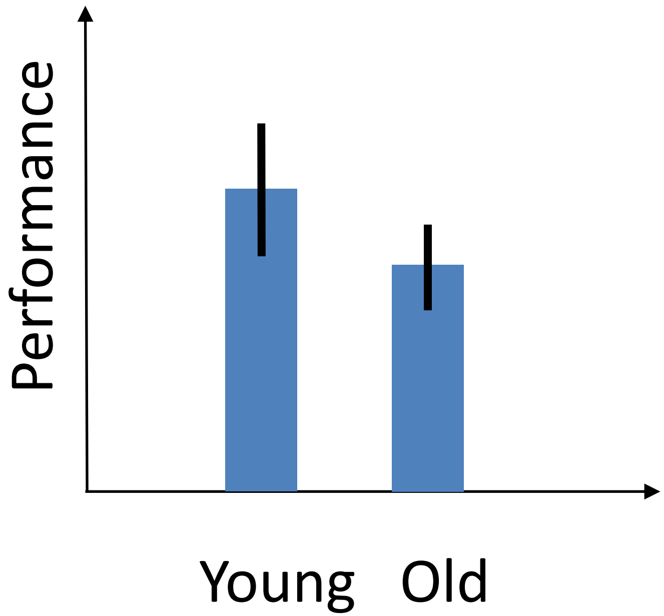


$$x_{ij} = v_i + \cancel{e_{ij}}$$

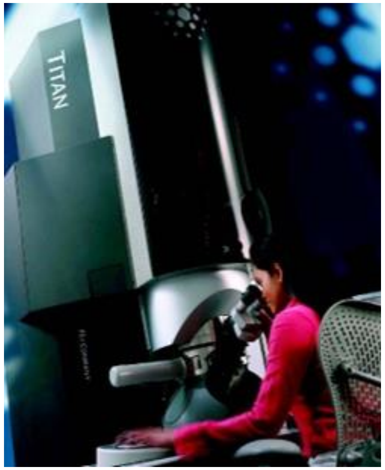
$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$

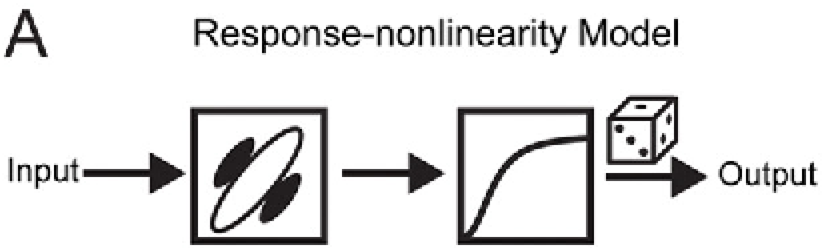


Cohen's d



$$x_{ij} = v_i + \cancel{e_{ij}}$$

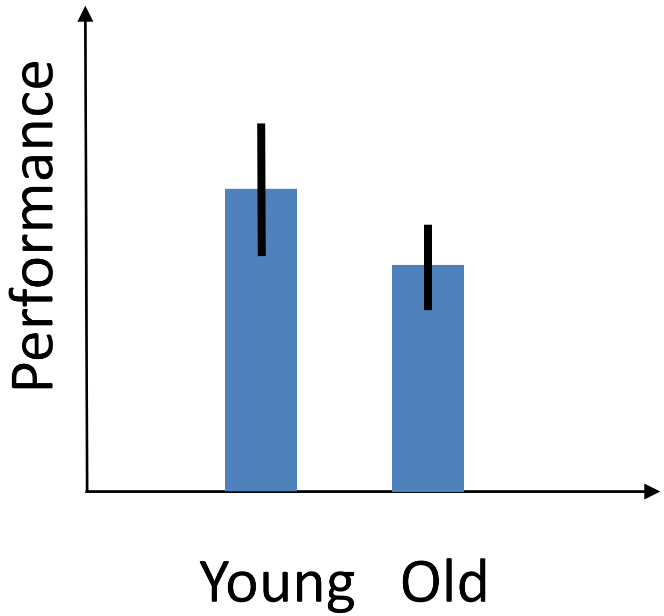




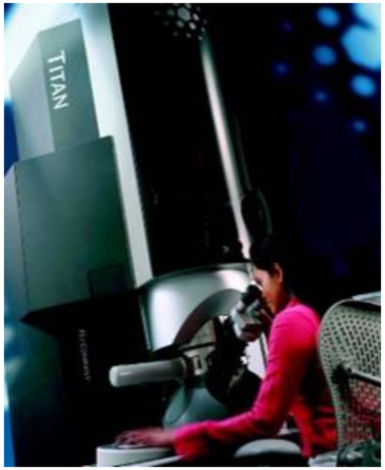
$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$

d = 0.8

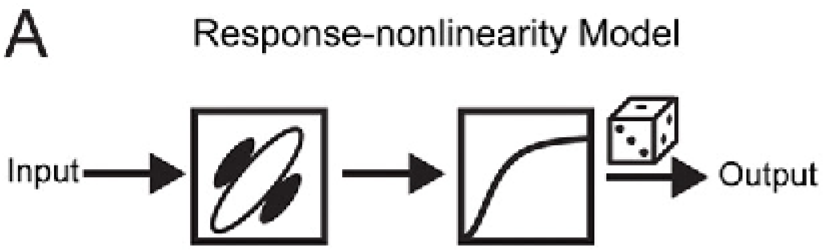
Cohen's d



$$x_{ij} = v_i$$



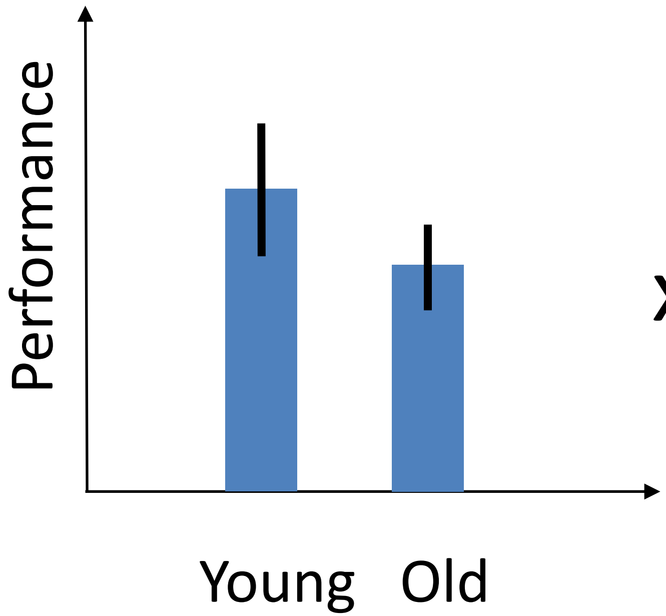
$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$



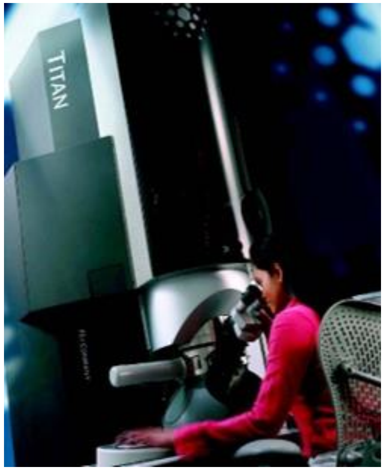
d = 0.8 << 4

65% discriminability

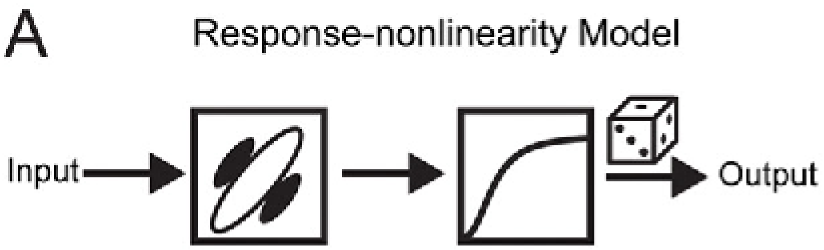
Cohen's d



$$x_{ij} = v_i + w_i + s_i \ldots.$$



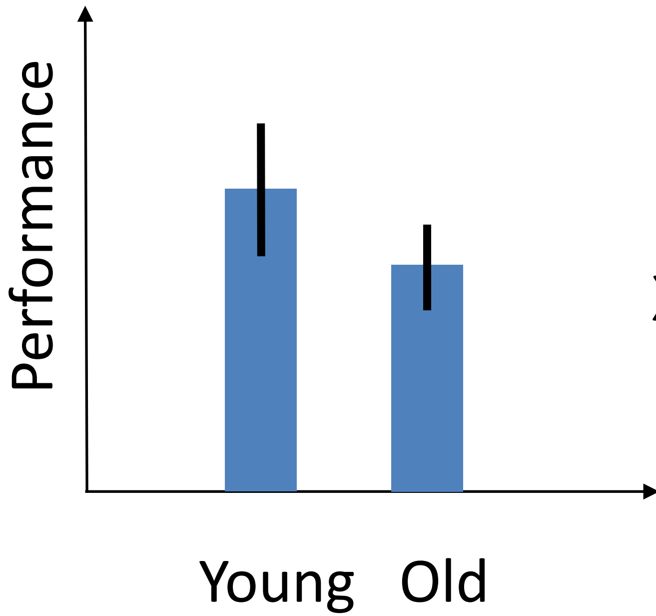
$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$



d = 0.8

65% discriminability

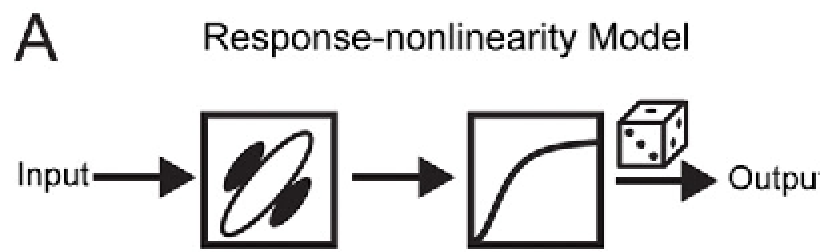
Cohen's d



Significance

$x_{ij} = v_i + w_i + s_i \ldots.$

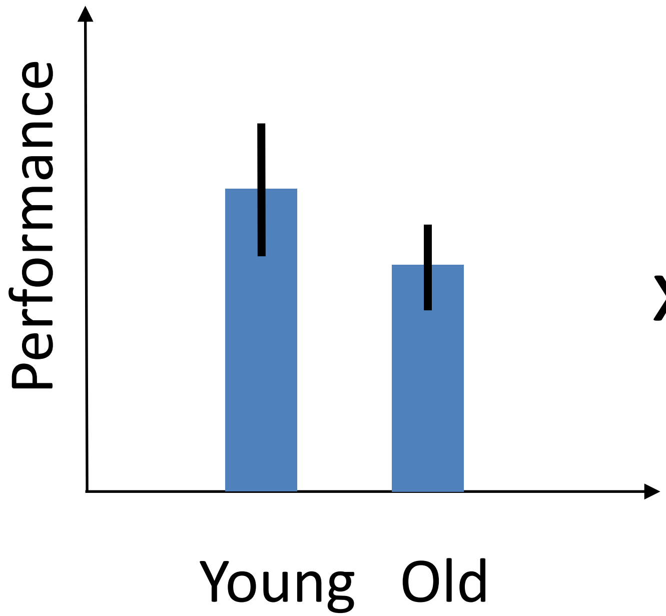
$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$



d = 0.8

65% discriminability

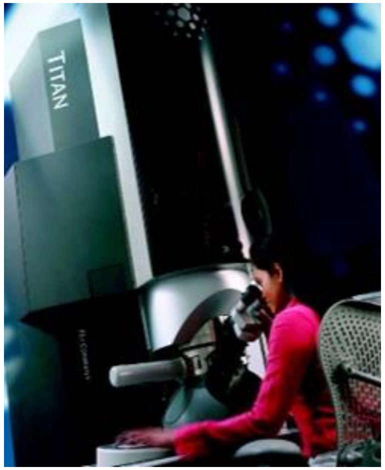
Cohen's d

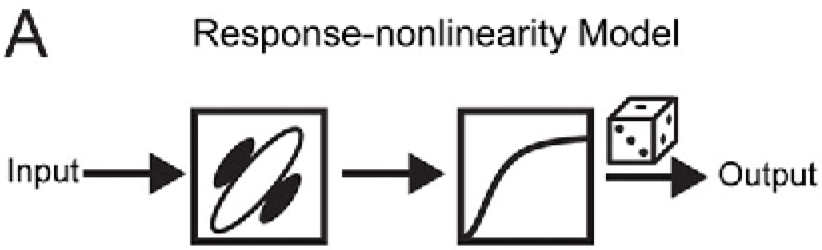


$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$

Significance p~d*n

$x_{ij} = v_i + w_i + s_i \ldots.$

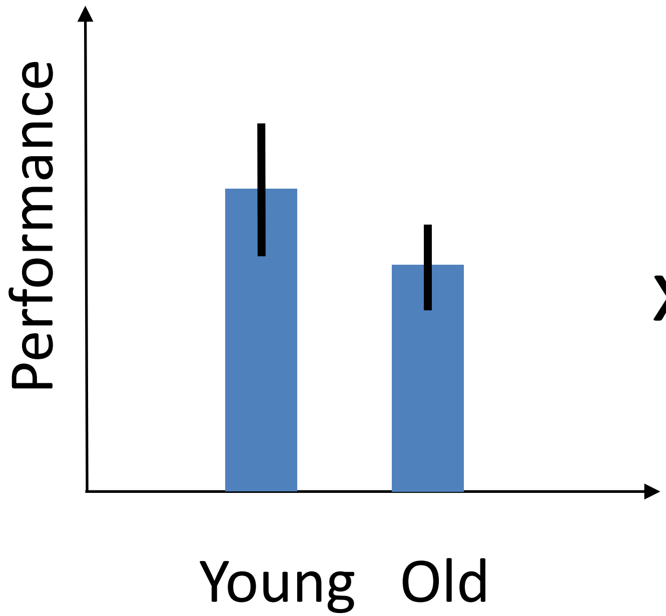




d = 0.8

65% discriminability

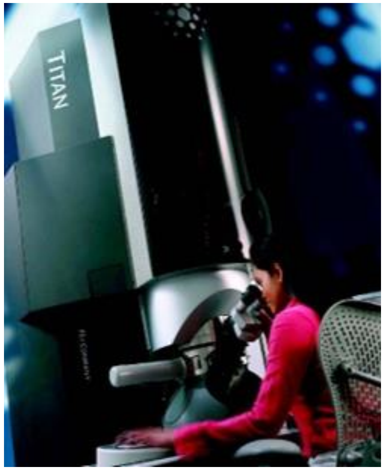
Cohen's d



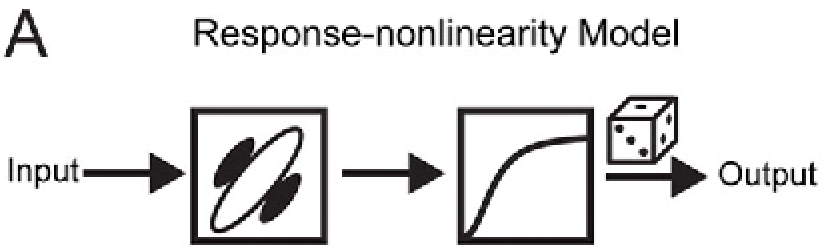
Significance

$x_{ij} = v_i + w_i + s_i$ ....

Many tests needed



$$d = \frac{\bar{x}_Y - \bar{x}_O}{s}$$



d = 0.8

65% discriminability

A Cohens d of 0.8 is not large if noise is low…

Strange Paradox I

Technically, we want no noise but we desperately count on it statistically

Strange Paradox II

$$x_{ij} = v_i + w_i + s_i \text{ ...... } + e_{ij}$$

We think we are averaging out noise (e_{ij}) with large samples but we kill true variability, ie signal (v_i, w_i ....)

END Class 8