Is there an association between cognitive and visual decline?

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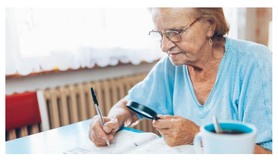
Introduction

Aging is associated with both cognitive and visual impairments.



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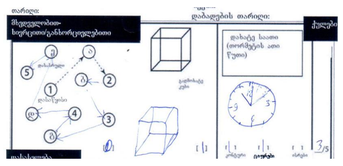


extract of MoCa test

The risk to suffer from cognitive decline is associated with visual impairments Reviews: Shang, Zhu, Wang, Ha, & He, 2021; Vu et al., 2021

Visual impairments = decreased visual acuity, visual field size or contrast sensitivity Tran et al., 2020; Mine et al., 2016; Ariswala et al., 2021; Varadaraj et al., 2021

Two theories:

1. Sensory deprivation: visual impairments cause cognitive decline

Zheng et al., 2018
Pevzner, 2017

2. Common cause: general age-related decline

Current study:

Go beyond visual acuity

Gupta, Vu & Lamoureux, 2021

(Dis)prove common cause theory

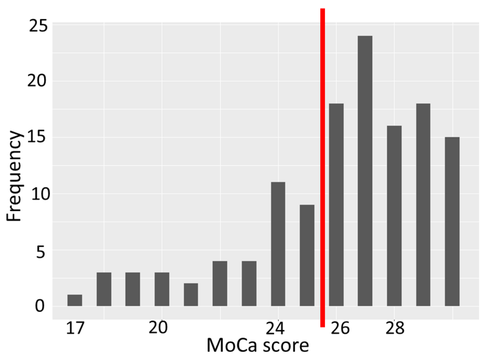
- No evidence in healthy younger and older adults for common factors underlying visual abilities

Reviews: Mollon et al., 2017; Peterzell, 2016; Tulver, 2019

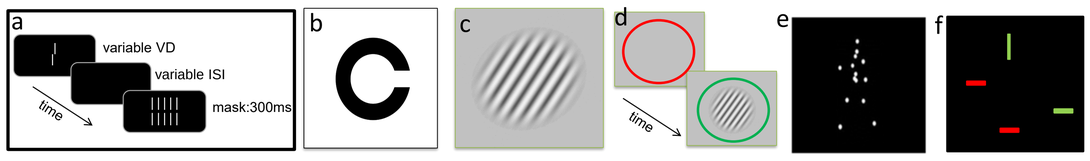
Methods

Montreal Cognitive assessment (MoCa)

Participants were split into two groups according to their total score: MCI group (i.e., 17>MoCa<26; n=39) and Healthy group (i.e., MoCa≥26; n=91). The 2 groups did not significantly differ in age nor sex but they significantly differ in education.



Battery of 19 visual tasks: vernier discrimination (duration and offset), visual backward masking (with a 5-and a 25-element grating; a), Freiburg visual acuity (b), orientation discrimination (c), contrast sensitivity (d), motion direction sensitivity, biological motion (for 200 ms and 800 ms, upward and inverted; e), simple reaction time, visual search (for four, nine and 16 distractors; f) and the Simon task (center, congruent and incongruent).



Preprocessing of visual variables:

- 4 variables excluded for ceiling (VD, BMup8) or floor (BMinv8, BMinv2) effects

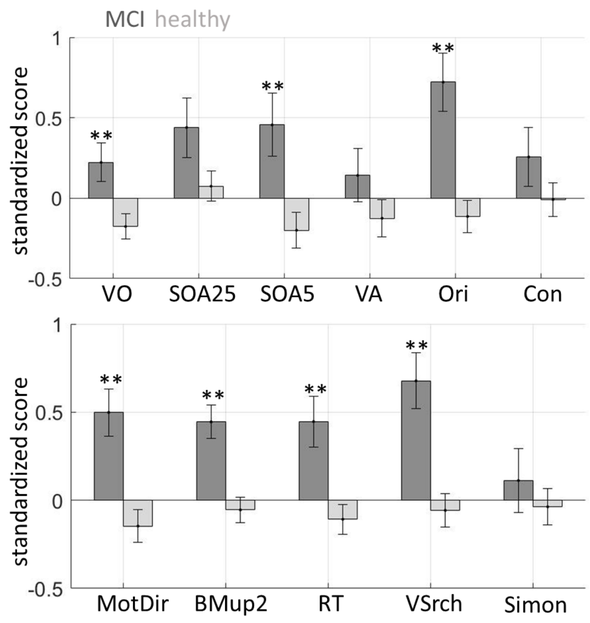
Variables were:

- Power transformed (Tukey)
- Standardized (modified z-scores)
- Outliers removed (3.5 criterium)
- Signs were flipped when needed so that low score = better performance

Nb. Missing data (3 %) were NOT imputed

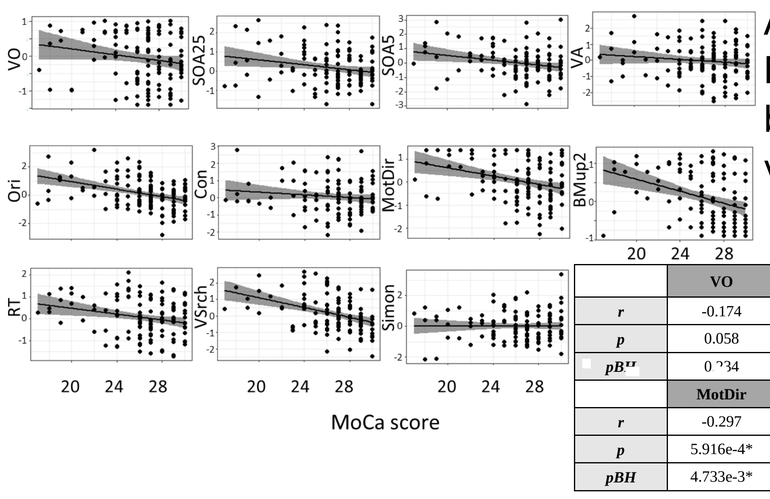
Results

MoCa performance and visual task performances



Low scores indicate better performance. Asterisks (**) indicate a significant difference in Welch's *t*-test between the two groups after Bonferroni-Holm correction for multiple comparisons ($p < 0.05$). Error bars represent standard errors of the mean (*SE*).

Overall, healthy group performed better than the MCI group.



A better performance in the MoCa test is associated to a better performance in the visual tasks.

	VO	SOA25	SOA5	VA	Ori	Con
r	-0.174	-0.212	-0.241	-0.123	-0.386	-0.119
p	0.058	0.019*	8.814e-3*	0.163	7.474e-6*	0.198
pBH	0.234	0.095	0.053	0.489	7.474e-5*	0.489
	MotDir	**BMup2**	**RT**	**VSrch**	**Simon**	
r	-0.297	-0.343	-0.235	-0.399	-0.000	
p	5.916e-4*	7.397e-5*	7.218e-3*	4.433e-6*	0.996	
pBH	4.733e-3*	6.657-4*	0.051	4.877e-5*	0.996	

Pearson's correlations (pairwise-deletion)

Asterisks (*) indicate a significant correlation ($p<0.05$). P-values are reported before (*p*) and after (*pBH*) Bonferroni-Holm correction for multiple comparisons.

Correlations

	VO	SOA25	SOA5	VA	Ori	Con	MotDir	BMup2	RT	VSrch	Simon
VO		-.09	-.14	-.11	-.20	-.09	.12	-.08	.14	-.01	-.10
SOA25	.28*		.64**	.23	.50*	.17	.26	.52*	.00	.34	-.37*
SOA5	.29*	.48**		.06	.20	.36	-.11	.37*	-.29	.33	-.20
VA	.08	.19	.01		.39*	.27	.23	-.01	.26	.19	-.15
Ori	.34*	.22*	.29*	.21*		.45*	.44*	.44*	.24	.28	-.05
Con	.26*	.21	.31*	.28*	.34*		.08	.11	-.07	-.11	.04
MotDir	.18	.17	.24*	.08	.28*	.18		.39*	.37*	.33	.19
BMup2	.16	.06	.18	.04	.17	.05	.37**		.17	.41*	.00
RT	.31*	.22*	.25*	.06	.29*	.25*	.13	.26*		.11	.06
VSrch	.24*	.04	.15	-.12	.34*	.27*	.30*	.21*	.20		-.17
Simon	-.11	-.19	.02	.02	.12	.05	.20	.03	-.12	.10	

Between-variable Pearson correlation coefficients for healthy (bottom triangle) and MCI (upper triangle) groups. The color scale from blue to red reflects effect sizes from $r = -1$ to $r = 1$ (white corresponds to $r = 0$).

Significant corr:
Healthy: 46% (3.6%)
MCI : 22% (1.8%)

Percentiles:25th,50th,75th
Healthy: 0.11,0.20,0.28
MCI:0.10,0.20,0.33

%variance explained by 1st eigenvalue (PCA)
Healthy: 27%
MCI: 29%

Conclusion

- Results show a strong association between visual impairments and mild cognitive impairment.
- Importantly, we found that not only visual acuity and contrast sensitivity correlate with the cognitive state but also more complex visual functions such as orientation discrimination and motion perception.
- In agreement with previous results with younger and healthy older adults, we found also weak correlations between most tests in older adults with mild cognitive impairment.
- Our results suggest that visual and cognitive abilities decline simultaneously, but they do so independently across visual and cognitive functions and across participants.

Perspective

- Visual functions that strongly relate to cognitive decline may open avenues for early detection and intervention of age-related impairments

Vu et al., 2021; Zheng et al., 2018

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