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CLINICAL MANIFESTATIONS

POSTER PRESENTATION

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NEUROPSYCHIATRY AND BEHAVIORAL NEUROLOGY

Changes in task-evoked pupil dilation as a marker of locus coeruleus function in healthy aging and Alzheimer's disease

Alina Zhunussova[1] | Clare Loane[2] | Elif Kurt[3] | Grazia Daniela Femminella[4] | Sabrina Lenzoni[1] | Millie Duckett[2] | Martina F Callaghan[5] | Nikolaus Weiskopf[6,7,8] | Ray Dolan[5,9] | Robert J Howard[10] | Emrah Düzel[2,11,12,13,14,15,16] | Dorothea Hämmerer[1,2,5,11,13,14]

[1]University of Innsbruck, Innsbruck, Austria

[2]Institute of Cognitive Neuroscience, University College London (UCL), London, United Kingdom

[3]Aziz Sancar Institute of Experimental Medicine, Istanbul University, Istanbul, Istanbul, Turkey

[4]University of Naples Federico II, Napoli, Italy

[5]Wellcome Centre for Human Neuroimaging, University College London (UCL), Queen Square Institute of Neurology, London, United Kingdom

[6]Institute of Neurology, University College London (UCL), London, United Kingdom

[7]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

[8]Felix Bloch Institute for Solid State Physics, Faculty of Physics and Earth Sciences, Leipzig University, Leipzig, Germany

[9]Max Planck Centre for Computational Psychiatry and Ageing, University College London, London, London, United Kingdom

[10]Division of Psychiatry, University College London, London, United Kingdom

[11]Center for Behavioral Brain Sciences (CBBS), Magdeburg, Germany

[12]University Hospital Magdeburg, Magdeburg, Germany

[13]German Center for Neurodegenerative Diseases (DZNE), Magdeburg, Germany

[14]Institute of Cognitive Neurology and Dementia Research (IKND), Otto-von-Guericke University, Magdeburg, Germany

Abstract

Background: Locus coeruleus (LC) is a primary source of noradrenalin in the brain and plays a complex role in human behavior. In healthy aging and Alzheimer's disease (AD), LC cell loss has been linked to a decline in overall cognitive function. This study aimed to explore age- and AD-related differences in a proxy measure of LC activity. Using pupil dilation (PD) as a non-exclusive proxy measure of the LC-NE system activity, we examined whether pupillometric recordings during cognitive tasks are possible in early AD and whether they reveal differences in attentional modulation in aging and AD.

Method: 37 subjects (14 healthy OA and 23 individuals with AD) completed an auditory and visual oddball task to assess attentional modulation; 62 subjects (22 healthy YA, 20 healthy OA, and 20 individuals with AD) completed a Simon task to assess attention and cognitive control. LC integrity was assessed using neuromelanin-sensitive MRI.

Result: A larger PD response for oddball compared to standard stimuli was observed, with no difference between OA and AD participants. In the visual task, greater PD correlated with faster reaction times (RTs) for hits in both groups, indicating the interindividual differences in PD can reflect heightened attentional involvement in aging and AD. Similarly, a consistent Simon effect, i.e., lower accuracy and longer RTs for incongruent trials, was observed in all groups, suggesting cognitive effort in discriminating between congruences. PD was higher for incongruent than congruent trials across all age groups, yet YA exhibited a less pronounced Simon effect, indicating age-related differences in attentional resource allocation with a potentially larger need in OA and AD for attentional control on incongruent stimuli. In YA, slower RTs correlated with smaller PD in incongruent trials. YA and AD individuals with a stronger Simon effect in PD showed faster processing for incongruent trials and better performance for congruent trials, respectively.

[15]Department of Neurology, Otto-von-Guericke University, Magdeburg, Germany

[16]Department of Psychiatry and Psychotherapy, Otto-von-Guericke University, Magdeburg, Germany

Correspondence
Alina Zhunussova, University of Innsbruck, Innsbruck, Austria.
Email: alina.zhunussova@uibk.ac.at

Conclusion: Using PD as a measure of attentional allocation and effort during cognitive control is possible in AD. Moreover, it allows for the assessment of interindividual differences in the extent of attentional modulation in AD. Assessing PD could be a useful tool for distinguishing between healthy aging and early AD.

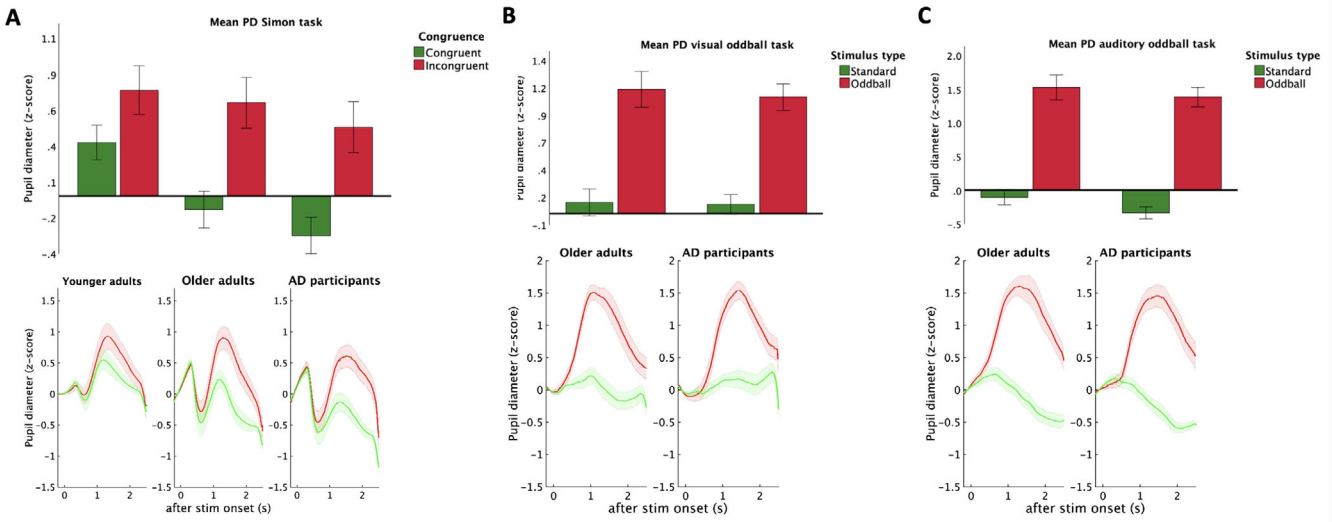

Figure 1. Mean PD diameter across the tasks. (A) PD response to congruent and incongruent Simon task stimuli. (B) PD response to oddball and standard stimuli in the visual task. (C) PD response to oddball and standard stimuli in the auditory task. Error bars represent one standard error.

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Table 1. Mean behavioral and PD results

Oddball Task	Stimulus type		Mean PD (z-score)	RT (s) / Hits (%)/ d' (%)
	Standard		-.075 (.060)***	N/A
	Oddballl		1.289 (.085)***	N/A
	Age group			
	OA		NS	NS / .944 (.019)**/ .942 (.024)*
	AD		NS	NS / .875 (.015)**/ .859 (.019)*
Modified Simon Task	**Congruence**		**Mean PD (z-score)**	**RT (s) / Accuracy (%)**
	Congruent		.002 (.074)***	.781 (.033)***/ .961 (.012)**
	Incongruent		.625 (.101)***	.977 (.040)***/ .932 (.014)**
	Age group x Congruence			
	YA	Congruent	.349 (.138)*	.534 (.056)***/ NS
		Incongruent	.671 (.190)*	.647 (.067)***/ NS
	OA	Congruent	-.093 (.130)***	.721 (.059)***/ NS
		Incongruent	.652 (.178)***	.907 (.070)***/ NS
	AD	Congruent	-.250 (.145)***	1.087 (.059)***/ NS
		Incongruent	.551 (.200)***	1.377 (.070)***/ NS

NS – not significant, N/A – not applicable. The standard error is presented within parentheses. Significance levels are denoted by symbols: * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$.