

Cognitive reserve influences the functional and structural organization of large-scale networks in dementing disorders



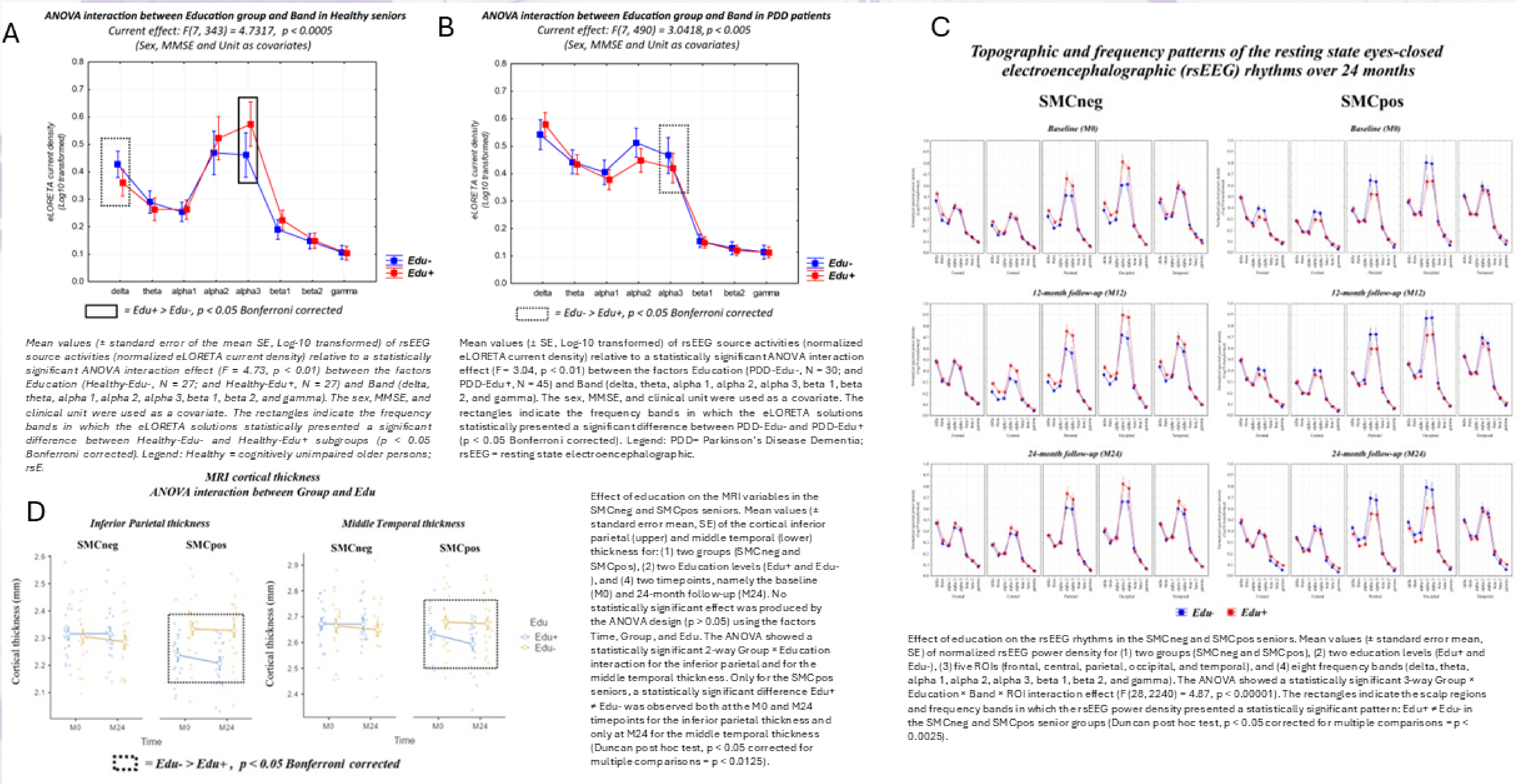
Susanna Lopez¹, C Del Percio¹, R Lizio¹, G Noce², A Soricelli^{2,3}, M Salvatore², B Güntekin⁴, G Yener⁵, F Massa^{6,7}, D Arnaldi^{6,8}, F Famà^{6,8}, M Pardini⁶, R Ferri⁹, F Carducci^{1,9}, F Stocchi^{10,11}, L Vacca¹⁰, C Coletti¹⁰, M Marizzoni¹², JP Taylor¹³, L Hanoğlu¹⁴, N Helvacı Yılmaz¹⁵, I Kıyı¹⁶, Y Özbek-İşbitiren¹⁶, A D’Anselmo¹⁷, L Bonanni¹⁷, R Biundo^{18,19}, F D’Antonio²⁰, G Bruno²⁰, A Antonini¹⁸, F Giubilei²¹, S Cuoco²², P Barone²², GB Frisoni^{23,24}, R Rotondo²⁵, F De Pandis^{11,25}, and Claudio Babiloni^{1,25*}

¹ Dept of Physiology and Pharmacology “Vittorio Erspamer,” Sapienza University of Rome, Rome, Italy; ² IRCCS Synlab SDN, Naples, Italy; ³ Dept of Medical, Movement and Well-being Sciences, University of Naples Parthenope, Naples, Italy; ⁴ Dept of Biophysics, School of Medicine, Istanbul Medipol University, Istanbul, Turkey; ⁵ Izmir University of Economics, Faculty of Medicine, Izmir, Turkey; ⁶ Dipartimento di Neuroscienze, Oftalmologia, Genetica, Riabilitazione e Scienze Materno-infantili (DiNOGMI), Università di Genova, Italy; ⁷ Clinica neurologica, IRCCS Ospedale Policlinico San Martino, Genova, Italy; ⁸ Neurofisiopatologia, IRCCS Ospedale Policlinico San Martino, Genova, Italy; ⁹ Oasi Research Institute – IRCCS, Troina, Italy; ¹⁰ IRCCS San Raffaele, Rome, Italy; ¹¹ Telematic University San Raffaele Rome, Rome, Italy; ¹² Biological Psychiatry Unit, IRCCS Istituto Centro San Giovanni di Dio Fatebenefratelli, Brescia, Italy; ¹³ Translational and Clinical Research Institute, Faculty of Medical Sciences, Newcastle University, UK; ¹⁴ Dept of Neurology, School of Medicine, Istanbul Medipol University, Istanbul, Turkey; ¹⁵ Parkinson’s Disease and Movement Disorders Center (PARMER), Istanbul Medipol University, Istanbul, Turkey; ¹⁶ Health Sciences Institute, Dept of Neurosciences, Dokuz Eylül University, Izmir, Turkey; ¹⁷ Dept of Aging Medicine and Sciences, University “G. d’Annunzio” of Chieti-Pescara, Italy; ¹⁸ Parkinson and Movement Disorders Unit, Study Center for Neurodegeneration (CESNE), Center for Rare Neurological Diseases (ERN RND), Dept of Neuroscience, University of Padua, Padua, Italy; ¹⁹ Dept of General Psychology, University of Padova, Padua, Italy; ²⁰ Dept of Human Neurosciences, Sapienza University of Rome, Rome, Italy; ²¹ Dept of Neuroscience, Mental Health, and Sensory Organs, Sapienza University of Rome, Rome, Italy; ²² Dept of Medicine, Surgery and Dentistry “Scuola Medica Salernitana”, Neuroscience Section, University of Salerno, Baronissi, Italy; ²³ Laboratory of Neuroimaging of Aging (LANVIE), University of Geneva, Geneva, Switzerland; ²⁴ Geneva Memory Center, Dept of Rehabilitation and Geriatrics, Geneva University Hospitals, Geneva, Switzerland; ²⁵ Hospital San Raffaele Cassino, Cassino (FR), Italy;

Background: The variability in the course of neurodegenerative diseases from the onset of clinical manifestations to dementia depends on various factors, including neurobiological and neurophysiological features that prevent or delay the onset of the disease. These features form a kind of cognitive reserve (CR). This reserve can be developed throughout a person’s lifetime through high educational attainment and related intellectual activities, such as work, cultural interests, and creative or leisure pursuits. CR may be physiologically associated with enhanced neurogenesis, synaptic plasticity, and neuronal efficiency in neuromodulation systems. It may also be associated with the brain’s ability to reorganize functional connectivity flexibly to compensate for neuropathological and neurodegenerative processes. A full, longitudinal characterization of the synergistic contributions to CR in relation to large-scale structural and functional brain networks may help to develop effective dementia prevention strategies.

Method: In several studies, we investigated whether educational attainment (a proxy for cognitive reserve) affects the structural and functional organization of large-scale networks, as revealed by biomarkers of resting-state EEG and magnetic resonance imaging (MRI) across various stages of cognitive impairment due to Alzheimer's disease (AD) and Parkinson's disease (PD).

Results: Participants in the healthy elderly with high CR (Edu+) exhibited greater posterior resting-state EEG alpha rhythms than those in the healthy elderly Edu- group (low CR; Fig. A). Conversely, Edu+ PD patients (Fig. B) and preclinical AD patients with subjective memory complaints who tested positive for AD biomarkers (SMCpos; Fig. C) exhibited reduced posterior resting-state EEG alpha rhythms. The latter group also showed lower parietal cortical thickness than Edu- SMCpos patients (Fig. D).



Conclusion: These findings suggest that evaluating cognitive reserve (CR) and other exposome factors may improve our understanding of how individuals are vulnerable to or resilient against cognitive impairment.