

Curriculum Vitae

PROFESSOR Carlo Alberto Marzi

1967: **M.D.** University of Florence Medical Faculty

Posts held: 1968-1982 Lecturer and Assistant Professor at the Institute of Human Physiology, University of Pisa (Headed by Giuseppe Moruzzi); 1983-88 Professor, Psychology Department, University of Padua, Italy; 1988-present: Professor, Department of Neurological, Neuropsychological, Morphological and Motor Sciences, University of Verona, Italy.

Visiting positions 1974-1976 Visiting Researcher, Department of Experimental Psychology, University of Oxford with a Joint Fellowship Royal Society-Accademia dei Lincei, Rome; 1993 Visiting Professor, Department of Psychology, University of Western Ontario, London, Ontario, Canada.

Membership of research-related boards/committees

Former Member, Scientific Committee, European Brain and Behaviour Society (EBBS).

Former Member, Scientific Committee European Neuroscience Association (ENA)

Former President, Italian Neuropsychology Society

Former President, European Brain and Behaviour Society (EBBS) 1994-1995

Former President, International Neuropsychology Symposium 2000-2005

Editorial boards

- Editor, Experimental Brain Research, Panel Behavioural Sciences and Neuropsychology, since 1994 -In the Editorial Board of Neuropsychologia and European Journal of Neuroscience

Funding ID Principal Investigator and National Coordinator of a Grant assigned biannually to carry out collaborative research with other Italian groups on "Cognitive and Neural Aspects of Selective Attention". In the last years the total amount of the Grant has been 1.539.351 Euro of which 237.507 to the Verona Unit. 2008: Grant of the Fondazione CariVerona: 90.000 Euro
-Awards of annual departmental research grants

Scientific Profile (last ten years)

My scientific activity concerns various topics within the areas of cognitive neuroscience and experimental psychology, namely: **Hemispheric differences and interactions, Visual Attention, Visual Imagery and the Cerebral Correlates of Visual awareness.**

Briefly, the specific contribution to the first area concerns both the study of **hemispheric differences** in normal individuals, as studied with lateralized visual input and that of **interhemispheric transfer** of visuomotor information in healthy or callosal sectioned participants or schizophrenic patients, see Marzi, Wiley Interdisciplinary Reviews: Cognitive Science, 1, 433-438, 2010 for a recent review. The latter topic of research has also been pursued recently with behavioural (Savazzi and Marzi, Neuropsychologia, 42, 1608-1618, 2004; Savazzi et al. Neuropsychologia, 45, 2417-2427, 2007; Florio et al., Neuropsychologia, 46, 2808-2815, 2008) or brain imaging techniques (Tettamanti et al., J. Neurophysiol., 88:1051-1058, 2002; Weber et al., 17, 113-123, 2005). A particularly important contribution has been demonstrating the role of the Superior Colliculus and its commissure for interhemispheric transfer of visuomotor information in patients with section of the Corpus Callosum.

The second area of interest concerns **visual attention**. By using a reaction time (RT) paradigm with lateralized visual presentations my collaborators and I have demonstrated that the distribution of attention across the visual field of patients with hemineglect, i.e. an impairment of visual attention as a consequence of a right hemisphere parietal-temporal lesion, is strongly asymmetric being biased toward the ipsilesional side (Natale et al, Neuropsychologia, 43, 1072-1085, 2005). This impairment has been shown in this and in subsequent studies to depend upon abnormalities in automatic, exogenous rather than endogenous attention. This finding has important general implications for understanding the neural bases of visuospatial attention and for rehabilitation of patients with hemineglect and has been followed by a brain imaging study carried

out by the applicant's group on healthy participants (Natale et al., *Eur. J. Neurosci*, 23, 2511-2521, 2006) in collaboration with S. Pollmann (then in Leipzig) that has further confirmed and expanded the original behavioural results. Furthermore, another recent study, in collaboration with H.O. Karnath in Tuebingen, has extended to oculomotor responses the result of an attentional asymmetry in hemineglect patients that can thus be generalized to different response modalities (Natale et al., *Neuropsychologia*, 45, 263- 272, 2007). More recent studies in collaboration with E. Macaluso in Rome have dealt with brain imaging correlates of reorienting of attention (Natale et al, *Neuropsychologia*, 48, 1160-1164, 2009; Natale et al *Human Brain Mapping*, 30, 2367-2381, 2009).

For the sake of brevity in this profile I will focus on the last two topics which represent my most recent main interests. In the last few years my coworkers and I have developed a new strategy to study **visual imagery** using a simple RT technique. After an acoustic tone participants are asked to form a vivid image of a previously shown visual stimulus and to press a key as quickly as possible. The results so far obtained by asking participants to imagine a visual stimulus in different parts of the visual field showed (Marzi et al., *Neuropsychologia*, 44, 1489-1495, 2006; Savazzi et al, *Neuropsychologia*, 2008) that visual imagery has a retinotopic organization because RT to mental images localized at increasing eccentricities along the visual field horizontal meridian are responded to more slowly than more central ones. This effect is similar to that commonly observed with real visual stimuli (see Chelazzi et al, *Vision Research*, 28, 95-104, 1988). Furthermore, more recently we found that visual imagery has several other similarities with perception for visual attributes such as intensity, contrast, motion and spatial frequency (Broggin et al., *Q J Exp Psychol.*, 65, 151-164, 2012). We will start soon (see present proposal) to study the neural correlates of visual imagery by testing hemianopic patients in the fMRI scanner as well as with MEG recording while forming mental images in the intact and hemianopic field. Subsequently, we plan to use visual imagery as a tool for stimulating the reorganization of a deafferented or lesioned visual cortex (present proposal).

The other area on which I am currently focusing most of my efforts concerns the **cerebral correlates of visual awareness**.

In recent years we developed an original behavioural paradigm to study implicit, that is, unconscious, vision, in either healthy or brain damaged participants. The basic procedure is similar to that of a phenomenon of divided attention that we have extensively studied in previous years, the Redundant Signal Effect (RSE). This paradigm enables one to compare simple manual RT to double as opposed to single stimuli. The double stimuli are presented one on each hemifield across the vertical meridian while the single stimuli are presented in a random sequence either to the left or to the right hemifield. In healthy participants one consistently finds a reliable speeding of RT to double stimuli. Our original finding was that a similar effect can be found in some hemianopic or hemineglect patients despite only one stimulus is visible during double presentations (Marzi et al., *Neuropsychologia*, 24:749-758, 1986; Marzi et al., *Neuropsychologia*, 34, 9-22, 1996; Tomaiuolo et al., *Brain*, 120, 795-803, 1997; Marzi et al. *Neuropsychologia*, 47, 1382-1385, 2009). This is a clear example of blindsight, that is, vision without perceptual awareness, as tested with an indirect bias-free procedure. Interestingly, a similar implicit redundancy gain was found in healthy participants in whom a stimulus in a pair was rendered invisible by lowering its intensity below perceptual threshold (Savazzi and Marzi, *Curr Biol*, 12, 403-407, 2002). In another study, we found that it is possible to obtain inhibition of return (a thoroughly studied and controversial attentional effect) with subliminal visual stimuli (Mele et al, *Neuropsychologia*, 46, 810-819, 2008). More recently, in collaboration with groups from Tilburg University (B. deGelder and M. Tamietto), Maastricht (R. Goebel) and Oxford (L. Weiskrantz) we found brain imaging (fMRI) evidence of the crucial role of the Superior Colliculus in mediating blindsight in a thoroughly studied patient (GY) with a unilateral lesion of the visual cortex (Tamietto et al., *J. Cogn. Neurosci.*, 22, 888-892, 2010).

Further work on other forms of conscious-unconscious dissociations in behaviour has been carried out by our group by using event related potential (ERP) recording. In one study (Minelli et al., *Exp. Brain Res*, 179, 683-690, 2007) we demonstrated that an electrophysiological correlate of the activation of the primary motor cortex (the lateralized readiness potential-LRP) can be detected even when subliminal visual stimuli do not elicit a motor response. In another study (Pavone et al., *Eur. J. Neurosci.*, 30, 1424-1431, 2009) we found that a neural correlate of error monitoring (the error related negativity-ERN) is present even when participants are not aware of the error committed. Thus, both motor preparation and error monitoring are similarly organized in both supra- and subthreshold visual processing.

Taken together these findings can be considered as an important starting point for understanding the neural bases of visual awareness. In particular, they suggest some similarity between blindsight and some aspects of subliminal perception and hint to a critical contribution of subcortical centres such as the Superior Colliculus

to implicit vision. In this proposal we will attempt to study the neural mechanisms responsible of transforming blindsight into conscious vision which, obviously, is the only one that counts for the patient.

Main Invitations to give lectures at International Conferences and Workshops (last 10 years)

- “*The Roots of Visual Awareness*”. Festschrift Meeting in honour of Professor Alan Cowey, Oxford, 2002.
 - International Congress on Movement, Attention and Perception, Poitiers, France, 2002
 - International Neuropsychology Symposium Annual Meeting, Mondello, Sicily, 2003
 - 1st Congress of the European Neuropsychological Societies, Modena, Italy, September 2004
 - International Neuropsychology Symposium Annual Meeting, Alghero, Sardinia, 2005.
 - VII International Congress of the Polish Neuroscience Society, Krakow, Poland, 2005
 - “*Consciousness, Memory, and Perception: Insights and Hindsight*”. A Festschrift in honour of Larry Weiskrantz, London, UK, 2006
 - Invited talk at the Symposium “*The roots of visual awareness*” XXV European Workshop on Cognitive Neuropsychology, Bressanone, Italy, 2007
 - Invited talk at the Symposium “*Brain connections and disconnections: Implications for neuro-cognitive modelling*” XXVI European Workshop on Cognitive Neuropsychology, Bressanone, Italy, 2008
 - Invited Discussant at the Symposium “*Cerebral dominance and interhemispheric relations in humans: Origins, mechanism and significance*” XXVI European Workshop on Cognitive Neuropsychology, Bressanone, Italy, 2010.
 - 3rd Congress of European Neuropsychological Societies, Amsterdam, Holland, 2010- Invited talk at the Symposium entitled: “*New evidence on the Blindsight phenomenon*”
- Invited lecture on “*Neural bases of unconscious (blindsight) and conscious residual vision following lesion of the primary visual cortex or optic radiation*” at the International Neuropsychological Society Mid-Year Meeting, Krakow, 2010
- Invited organizer of a Symposium on “*Neural Bases of Implicit vision*” at the International Neuropsychological Society Mid-Year Meeting, Krakow, 2010
 - Invited lecture on “*Hemispheric specialization and psychosis*” at FENS, IBRO, SFN Advanced School of Neuroscience “*Brain Evolution and its consequences for brain pathology*”, Naples, 2010
 - Invited lecture on “*Attention*” at 3rd Verona Neurosurgical Symposia, Verona, 2011.
 - Accepted Symposium proposal at the IBRO meeting in Florence, July 2011 entitled: “*Blindsight in Action: residual visuomotor functions after lesions of primary visual cortex*”
 - Accepted Symposium proposal at the Annual Meeting of the European Brain and Behaviour Society (EBBS), Sevilla September 2011 entitled: “*Interactions between conscious and unconscious vision in the normal and brain damaged brain*”

Specific organisational role at international conferences

- Organiser, as President of the Symposium, of five International Neuropsychology Symposium Annual Meetings, 2000-2005.
- Organiser, International Workshop “*The Physiology of Mind*”, Pavia, Italy, 2007

Major contributions to early careers of excellent researchers: S. Aglioti, (Rome), C. Cavina-Pratesi (Durham, UK), L. Chelazzi (Verona); M. Corbetta (St. Louis, USA,) M. Girelli, (Verona) A. Maravita (Milan), C. Miniussi, (Brescia); E. Natale (Milan), S. Savazzi, (Verona), F. Tomaiuolo (Volterra, Pisa); I. Sperandio, London, Ontario.

International Scientific Collaborations: Professor H.-O., **Karnath**, Center of Neurology, Hertie-Institute for Clinical Brain Research, University of Tübingen, Germany; Professor S. **Pollmann**, (then at) Day Clinic of Cognitive Neurology, University of Leipzig, Leipzig, Germany; Professor M. **Goodale**, Department of Psychology, University of Western Ontario, London, Ontario, N6A 5C2, Canada; Drs. B. **Weber**, M. **Regard** and P. **Brugger**, University Hospital Zurich, Switzerland; Dr. B. **Anderson**, Brown University, Department of Neuroscience, Providence, RI, USA. Drs. B. **Lee**, SUNY Optometry, New York, USA and V. **Di Lollo**, Department of Psychology, Simon Fraser University, Burnaby, British Columbia, Canada; Professor J. **Rothwell**, Sobell Dept, Institute of Neurology, Queen Sq, London, U.K. and Professor J. **Sanes**, Department of Neuroscience, Brown Medical School, Providence, RI, USA; Professors. A. **Ptito**, M. **Ptito**

and T. Paus (then at) Montreal Neurological Institute McGill University, Montreal, Quebec, Canada. **W. Kentridge** and **C. Heywood**, Durham, UK; **B. deGelder** and **M. Tamietto**, Tilburg University, Holland. **A. Caramazza** (Harvard, Boston) and **A. Lingnau**, Trento, Italy

Publications of the last five years

Weber, B., Treyer, V., Oberholzer, N., Jaermann, T., Boesiger, P., Brugger, P., Regard, M., Buck, R., Savazzi, S., and Marzi, C.A.. Attention and interhemispheric transfer: A behavioral and fMRI study. Journal of Cognitive Neuroscience, 17, 113-123, 2005.

Natale, E., Posteraro, L., Prior, M. Marzi, C.A. What kind of visual spatial attention is impaired in neglect? Neuropsychologia, 43, 1072-1085, 2005.

Miniussi, C., Marzi, C.A., Nobre A.C. Modulation of brain activity by selective task sets observed using event-related potentials. Neuropsychologia, 43, 1514-1528, 2005.

Marzi CA, Mancini F, Metitieri T, Savazzi S. Retinal eccentricity effects on reaction time to imagined stimuli. Neuropsychologia 44, 1489-1495, 2006.

Marzi CA. Dissociazione fra processi consci ed inconsci nella "visione cieca". In: Evoluzione biologica e i grandi problemi della biologia - Neurobiologia della coscienza - XXXII Seminario. Roma, 24-26 febbraio 2005, Roma: Bardi Editore/Accademia Nazionale dei Lincei, p. 179-192, 2006.

Cavina-Pratesi C, Valyear KF, Culham JC, Kohler S, Obhi SS, Marzi CA, Goodale MA. Dissociating arbitrary stimulus-response mapping from movement planning during preparatory period: evidence from event-related functional magnetic resonance imaging. Journal of Neuroscience, 26, 2704-2713, 2006.

Natale E, Marzi CA, Girelli M, Pavone EF, Pollmann S. ERP and fMRI correlates of endogenous and exogenous focusing of visual-spatial attention. European Journal of Neuroscience, 23, 2511-2521, 2006.

Natale E, Marzi CA, Bricolo E, Johannsen L, Karnath HO. Abnormally speeded saccades to ipsilesional targets in patients with spatial neglect. Neuropsychologia, 45, 263-272, 2007.

Minelli A, Marzi CA, Girelli, M. Lateralized readiness potential elicited by undetected visual stimuli. Experimental Brain Research, 179, 683-690, 2007.

Savazzi S, Fabri M, Rubboli G, Paggi A, Tassinari CA, Marzi CA. Interhemispheric transfer following callosotomy in humans: role of the superior colliculus. Neuropsychologia, 45, 2417-2427, 2007.

Savazzi S, Marzi CA. Does the redundant signal effect occur at an early visual stage? Experimental Brain Research, 184, 275-281, 2008.

Savazzi S, Mancini F, Marzi CA. Interhemispheric transfer and integration of imagined visual stimuli. Neuropsychologia, 46, 803-809, 2008.

Mele, S., Savazzi, S., Marzi, C.A. and Berlucchi, G. Reaction time inhibition from subliminal cues: Is it related to inhibition of return? Neuropsychologia, 46, 810-819, 2008.

Maravita, A., Bolognini, N., Marzi, C. A., Bricolo, E., & Savazzi, S. Is audiovisual integration subserved by the superior colliculus in humans? *Neuroreport*, 19, 271-275, 2008.

Florio V, Marzi CA, Girelli A, Savazzi S. [Enhanced redundancy gain in schizophrenics: a correlate of callosal dysfunction?](#) *Neuropsychologia*, 46, 2808-2815, 2008.

Boulinguez P, Savazzi S, Marzi CA. [Visual trajectory perception in humans: Is it lateralized? Clues from online rTMS of the middle-temporal complex \(MT/V5\).](#) *Behavioural Brain Research*, 197, 481-486, 2009.

Brignani D, Guzzon D, Marzi CA, Miniussi C. [Attentional orienting induced by arrows and eye-gaze compared with an endogenous cue.](#) *Neuropsychologia*, 47, 370-381, 2009

Marzi CA, Mancini F, Savazzi S. [Interhemispheric transfer of phosphenes generated by occipital versus parietal transcranial magnetic stimulation.](#) *Experimental Brain Research* 192, 431-41, 2009

Marzi CA, Paulesu E, Bottini G. [The physiology of mind.](#) *Experimental Brain Research* 192, 303-306, 2009.

Bellani, M, Marzi, CA, Brambilla, P. Interhemispheric communication in schizophrenia, *Epidemiologia e Psichiatria Sociale*, 18, 19-22, 2009

Marzi, C.A., Mancini, F., Metitieri T., Savazzi, S, Blindsight following visual cortex deafferentation disappears with purple and red stimuli: A case study. *Neuropsychologia*, 47, 1382-1385, 2009.

Savazzi and Marzi. From the laboratory to the operating room: visuo-spatial cognition. *Rivista Medica*, Special Issue 1: Awake Surgery and Cognitive Mapping, 2009.

Natale E, Marzi CA, Macaluso E. FMRI correlates of visuo-spatial reorienting investigated with an attention shifting double-cue paradigm. *Human Brain Mapping*, 30, 2367-2381, 2009

Marzi CA, Mancini F, Metitieri T, Savazzi S. [Blindsight following visual cortex deafferentation disappears with purple and red stimuli: a case study.](#) *Neuropsychologia*, 47, 1382-1385, 2009.

Marzi CA, Mancini F, Sperandio I, Savazzi S. [Evidence of midline retinal nasotemporal overlap in healthy humans: a model for foveal sparing in hemianopia?](#) *Neuropsychologia*, 47, 3007-3011, 2009.

Pavone EF, Marzi CA, Girelli M. [Does subliminal visual perception have an error-monitoring system?](#) *European Journal of Neuroscience*, 30, 1424-1431, 2009.

Bellani M, Marzi CA, Savazzi S, Perlini C, Cerruti S, Ferro A, Marinelli V, Sponda S, Rambaldelli G, Tansella M, Brambilla P. [Laterality effects in schizophrenia and bipolar disorder.](#) *Experimental Brain Research*, 201, 339-344, 2010.

Sperandio, I, Savazzi S, Gregory RL, Marzi CA Visual reaction time and size constancy. *Perception*, 38, 1601-1609, 2010

Sperandio I, Savazzi S, Marzi CA. [Is simple reaction time affected by visual illusions?](#) Experimental Brain Research, 201, 345-350, 2010.

Tamietto M, Cauda F, Corazzini LL, Savazzi S, Marzi CA, Goebel R, Weiskrantz L, de Gelder B. [Collicular Vision Guides Nonconscious Behavior](#). Journal of Cognitive Neuroscience, 22, 888-892, 2010

Marzi CA. Asymmetry of interhemispheric communication. Wiley Interdisciplinary Reviews: Cognitive Science, 1, 433-438, 2010

Natale E, Marzi CA, Macaluso E. Right Temporal-Parietal Junction engagement during spatial reorienting does not depend on strategic attention control. Neuropsychologia, 48, 1160, 1164, 2010.

Goodale MA, Lacquaniti F, Marzi CA. [200th anniversary volume, issue 1: behavioural sciences and neuropsychology](#). Exp Brain Res, 200, 1-2, 2010

Guzzon D, Brignani D, Miniussi C, Marzi CA. [Orienting of attention with eye and arrow cues and the effect of overtraining](#). Acta Psychol (Amst), 34, 353-362, 2010.

Ruzzoli M, Marzi CA, Miniussi C. [The neural mechanisms of the effects of transcranial magnetic stimulation on perception](#). J Neurophysiol, 103, 2982-2989, 2010

Ruzzoli M, Abrahamyan A, Clifford CW, Marzi CA, Miniussi C, Harris JA. [The effect of TMS on visual motion sensitivity: an increase in neural noise or a decrease in signal strength?](#) J Neurophysiol. , 49, 3648-55, 2011

Broggin E, Savazzi S, Marzi CA. [Similar effects of visual perception and imagery on simple reaction time](#). Q J Exp Psychol (Hove), 65, 151-164, 2012.