

# CURRICULUM VITAE

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Dec 2016

## SUMMARY

Maria Concetta Morrone graduated in Physics from the University of Pisa in 1977 and trained in Biophysics at the Scuola Normale Superiore from 1973 to 1980. Following research positions in the Department of Psychology of the University of Western Australia, the Scuola Normale Superiore of Pisa, and the CNR Institute of Neuroscience, she was appointed Professor of Psychophysiology in the Faculty of Psychology of the Università Vita-salute S Raffaele Milan in 2000. From 2008 she is Professor of Physiology of the School of Medicine of University of Pisa. She has been awarded major national and international prizes for scientific achievements, including the inaugural *Campbell Award* for Australian Neuroscience, the National Prize for Physiopathology from the *Accademia dei Lincei* (2002), the Perception Lecture (Budapest: 2004), and the Kofka Prize in development and perception (Giessen: 2011). In 2014, she was elected member of the prestigious *Accademia dei Lincei*. From an initial interest in biophysics and physiology, where she made many seminal contributions, she moved then on to psychophysics and visual perception. Her research career has been dedicated to understanding the function of the mammalian visual system, where she has made many important contributions fundamental in shaping the field. The research involves the study of both humans and animals using a variety of techniques, including psychophysics, electro-physiology, functional brain imaging, computational modelling and artificial intelligence. The simultaneous mastery of all these techniques has made it possible to tackle a wide spectrum of problems, approaching each problem from a different perspective in a truly interdisciplinary manner. Over the years the research has spanned most active areas of vision research, including spatial vision, development, plasticity, attention, colour, motion,

robotics, vision during eye movements and more recently multisensory perception and action. Prof. Morrone has published some 150 publications in excellent international peer-review journals, including *Nature* and her sister journals, *Neuron*, *Current Biology* and *Trends in Neuroscience*. During the course of her career she has established three new laboratories in Perth, Pisa, and Milan, all with state-of-the-art technology and all still active and productive. She is Chief Editor of major specialized journals and one of the founding editors of the first Open Access journal in Life Sciences.

## **Education**

- 1977:** BSc (cum laude) in physics, Pisa University
- 1977-1981:** Doctoral Fellowship in biophysics, *Scuola Normale Superiore*, Pisa
- 1978:** Fellowship from *Universitätsgesellschaft*, University of Ulm, Gemany
- 1981-1995:** *Ricercatore* ("Assistent Professor"), *Scuola Normale Superiore*, Pisa.
- 1982-1987:** Senior Research Officer, Department of Psychology, University of Western Australia.
- 1995-2000:** *Primo Ricercatore* ("Principal Scientist"), *Istituto di Neurofisiologia* CNR, Pisa.
- 2000** Acting director of the *Istituto di Neurofisiologia* CNR.
- 2000-2008** Professor of Psychophysiology, Faculty of Psychology, *Università Vita-Salute San Raffaele*, Milan.
- 2008-** Professor of Physiology (BIO/09) Medical School, University of Pisa.
- 2008-** Part-time Senior Researcher -Robotics, Brain and Cognitive Sciences Department - Italian Institute of Technology (IIT)- Genova
- 2008-** Director of Vision Laboratory , IRCCS Fondazione Stella Maris, - Pisa

## **PRIZES and HONOURS:**

- 1987** Campbell Award from the Australian Neuroscience Society.
- 2002** Accademia Dei Lincei: "*Premio Nazionale del Ministro per i Beni e le Attività Culturali*" for Physiology and Pathology.
- 2004** *The Perception Lecture*, European Conference of Visual Perception, Budapest.
- 2006** Elected member of the International Neuropsychology Symposium
- 2011** The Koffka Medal in development and perception, Giessen
- 2012** Program committee Forum for European Neuroscience Society (FENS)
- 2013** Awardee of an ERC-IDEA Advanced Grant
- 2014** Member (Socio Corrispondente) of the Accademia dei Lincei - "Classe di Scienze di Fisiche, Matematiche e Naturali, Categoria V - Sezione Fisiologia, Farmacologia e Neuroscienze".

## **RECENT PROFESSIONAL RESPONSIBILITIES:**

**Founding editor** of *Journal of Vision* (2000-2012), the first fully electronic journal in neuroscience.

**Member of the Editorial Board** (1992-1996) and **Section Editor** of the Computational Vision Section (1997-2000) of *Vision Research*.

**Founding Editor in Chief** (2010-2015) of Journal *Multisensory Research*

**Editor and Advisor Board Member (2015-present)** of *Scientific Report* of Nature Publishing Group

**Associate Editor** (2017) of Journal of Neuroscience

**Faculty Member** (2017) of Faculty 1000 Prime

**Editorial Board (2016)** of *Neuroscience Research*

**Guest Editor (2016)** Volume 29, Special Issue on “Hot Topics in Multisensory Processing Selected articles from the IMRF 2015 — 16th International Multisensory Research Forum, Pisa,” with M. Ernst

**Scientific Advisory Committee Member** (2014- ) of the Département d'Etudes Cognitives of the Ecole Normale Supérieure, Paris.

**Panel Member** (2016- ) of ERC LS5 advance grants

**Coordinator** (2017 - ) of the Master Degree in Neurosciences, University of Pisa

**Member** (2015-) of Consiglio Scientifico Imago 7

**Member of the selection committee of Visual Science Society (VSS) Board** 2007-2008.

**Editor** of the 50-year celebration issue of *Vision Research*

**Member (2005-2006) and chair (2006-2007) of the quality control committee** for the University Vita-Salute “San Raffaele”.

**Member** (2011-2012) of the Research Committee for bio-science of Pisa University

**Italian National Contact Point** (2011 -2014) of the COST Action TIMELY

**Guest Editor (2007)** Special Issue “Image Perception” of the EURASIP Journal on Applied Signal Processing.

**Guest Editor (2011)** of the special issues **50<sup>th</sup> anniversary of Vision Research**

## **Conference Organization:**

**Organiser of the “15th European conference on visual perception” (ECVP)** in Pisa 1992.

**Organiser** (together with Giovanni Cioni, David Burr and Adriana Fiorentini) of the 5th Meeting of the Child Vision Research Society, Pisa, 1997.

**Organiser** of the “3rd Annual Vision Research Conference – Pre-attentive and Attentive Mechanisms in Vision” Fort Lauderdale, Florida, USA, 1997, with other members of the Editorial Board of *Vision Research*.

**Organiser** of symposium “The Neural Mechanisms of Time” for the International Neuropsychology Society (INS), Teneriffe 2008.

**Organiser** of the international symposium “**Multi-sensory space perception**” with Prof. Burr, Sandini and Gori, Sestri Levante 19-21 Luglio 2011

**Organiser** of the international symposium “**Active Vision**” with Prof. Burr. S Elia a Pianisi (CB) 12-19 June 2013.

**Organiser** of symposium “**Multisensory neural maps for body schema, action and perception: development and dysfunction**” with Prof Ladavas and Roeder for the International Neuropsychology Society (INS), Nerja- Málaga, Spain 25-29 June, 2013

**Member of the Organizer Committee of the XV Congress of the Italian Society of Neuroscience Rome 3-5 Ottobre 2013**

**Program Committee Member FENS FORUM 2014**

**International Forum of Multisensory research**, Pisa 12-16 June 2015 with Roberto Arrighi and Marco Cicchini

### **Other positions**

**Visiting Scholar** 1994-1997 Boston University - Dept. of Biomedical Engineering.

**Adjunct Professor** (2001-2004) of the Department of Psychology of the University of Western Australia.

**Visiting Professor** (2001) Center for Neuronal Science - New York University NY.

**Distinguished Scholar** (2002) Smith-Kettlewell Eye Research Institute, San Francisco, for collaborative research with Susanne McKee and Preeti Verghese.

**Consultant** for the “Fondazione Stella Maris” (1998-2013) – Center for research in developmental neurology and neuro-rehabilitation.

### **CONSULTANT FOR THE FOLLOWING FUNDING AGENCIES:**

European Community – 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> Framework Program (both for *Life Science* and *Information Society Technologies* calls)

Reviewer for ERC program – Young Investigator Award

MIUR - IT

Reviewer for Human Frontier Science Program

"National Science Foundation" (USA).

Australian Research Council.

Health Research Council of New Zealand

“The Wellcome Trust”- UK

“Biotechnology and Biological Sciences Research Council” – UK

French National Grants “ACI 2002”

French National Grants “CNRS ATIP”

### **Habitual referee for**

*Science*  
*Nature Neuroscience*  
*Neuron*  
*Current Biology*  
*Journal of Neuroscience*  
*Cerebral Cortex*  
*Trends in Cognitive Sciences*  
*Brain*  
*Proceedings of The Royal Society*  
*Journal of Optical Society of America*

*Journal Neurophysiology*  
*Journal Physiology*  
*Perception*  
*Perception and Psychophysics.*  
*Spatial Vision*  
*Psychopharmacology*  
*Visual Neuroscience.*  
*Vision Research*  
*European Journal of Neuroscience.*

**Recent Public lectures and out-reach activity:**

**Infinitamente: Fattore Umano Cervello e coscienza.** March 2010, Verona

**7<sup>th</sup> World Conference Future of Sciences.** Mind: the essence of humanity. September 2011, Venice

**Infinitamente: Tempo, Spazio ed Infinito.** March 2012, Verona

**Accademia Nazionale dei Lincei.** Lecture to the general public on “Lo spazio, il tempo e I numeri nel cervello” Gennaio 2013

**Coordinator** of Polo del Molise (2013 - ) “Fondazione Lincei per la Scuola”.

**Member** (2016) of 100 ESPERTE

**Member** (2015) of Top Italian Scientists

**SUMMARY OF PUBLICATIONS (current on 5-2017)**

<b>Journal</b>	<b>N Pubs</b>	<b>IF</b>	<b>Total Imp</b>
<i>Nature</i>	8	22.3	178.4
<i>Trends in Neurosc (TINS)</i>	2	18	36.0
<i>Nature Neuroscience</i>	5	15	75.0
<i>Neuron</i>	1	14	14.0
<i>Plos Biology</i>	2	11.9	23.8
<i>Current Biology</i>	15	10.9	163.5
<i>J. of Neuroscience</i>	12	8.4	100.8
<i>Cortex</i>	1	6.08	6.08
<i>J. Physiology</i>	5	4.8	24.0
<i>J. of Cognitive Neurosc</i>	2	4.5	9.0
<i>Neuroimage</i>	1	6.4	6.4
<i>Scientific Report</i>	1	5.6	5.6

<i>J. Neurophysiology</i>	6	3.9	23.4
<i>Trends in Cog Science (TICS)</i>	1	9.7	9.7
<i>Proc. Roy. Soc.</i>	11	4.6	50.6
<i>Neuroreport</i>	1	2.9	2.94
<i>Philos Trans of Biol Scienc B</i>	1	6.05	6.05
<i>Plos One</i>	2	4.4	8.8
<i>Neuropsychologia</i>	1	4.2	4.2
<i>European J Neuroscience</i>	1	3.9	3.9
<i>J of Vision</i>	15	4.2	62.4
<i>Inv. Ophtal Vis Scie</i>	1	3.6	3.6
<i>Vision Res.</i>	34	2.2	74.8
<i>Exp Brain Res.</i>	8	2.4	19.2
<i>Behav Res Methods</i>	1	3.9	3.9
<i>Visual Neuroscience</i>	7	2.1	14.7
<i>Brain Res.</i>	1	2.8	2.8
<i>Behav. Brain Res</i>	2	2.6	5.2
<i>J. Opt. Soc. Am.</i>	3	2	6
<i>Int. J. Psychophy</i>	1	2.2	2.2
<i>Perception</i>	3	1.1	3.3
<i>Multisensory Research</i>	2	1	2
<i>Pattern Recognition Letters</i>	2	0.95	1.9
<i>Frontiers in System Neurosc</i>	1		
<i>Book chapters:</i>			
<b>Review on invitation</b>	<b>15</b>		
<i>others</i>	<b>11</b>		
<b>Total</b>	<b>185</b>		<b>946.4</b>

On 5-2017: Citations (**ScHolar Index**): **11413**. **Hirsch factor**: **55**

### RECENT MAJOR GRANTS

“**PRIN Miur**” (2006-2007) National coordinator of project: “Dynamic vision: keeping vision stable in the face of continual eye-movements.”.

**FP6-2005-NEST-Path (2007-2010)** “MEMORY”. Coordinator, with partners: University of Marburg – Germany; University of Applied Science – Ticino – Switzerland; IIT CNR Pisa – Italy.

**“PRIN Miur” (2008-2010)** National coordinator of project: “Keeping vision stable in the face of continual eye-movements”.

**ISA-2010: Coordinator Prof Lacquaniti. 2011-2012.** “ Fusione audio-visiva”.

**“PRIN Miur” (2011-2013)** National Coordinator of project: “Neuronal mechanisms for the perception of space, time and number”

**“Marie Curie International Outgoing Fellowship” (2011-2014)** European Union - 7th Framework Programme – Project “AWESoMe” Coordinator. Beneficiary Dr Paola Binda

**ERC- IDEA Advanced Grant (2014-2019)** 7th Framework Programme “Early Cortical Sensory Plasticity and Adaptability in human adults: **ECSPLAIN” 2014-2019**

**“Marie Curie ITN” – Horizon 2020 (2015- 2019)** “Training the Next Generation of European Visual Neuroscientists for the benefit of innovation in health care and high-tech industry” **2015-2019**

**Fondazione Roma – (2015-2018)** “Cortical Plasticity in Retinitis Pigmentosa: an integrated study from animal models to humans” . Coordinator

**“PRIN Miur” (2016-2019)** “Adult visual cortex plasticity: from animal models to humans”. Coordinator

## RESEARCH INTERESTS

My research career has been dedicated to studying the function of the mammalian visual system. The research has involved studying both humans and animals using a variety of techniques, including psychophysics, electro-physiology, functional brain imaging, computational modelling and artificial intelligence. The simultaneous use and mastering of all these techniques has made it possible to tackle a wide spectrum of problems and to approach each problem from different levels and perspectives in a truly interdisciplinary manner. Over the years the research has spanned almost all active areas of vision research, including spatial vision, development, attention, colour, motion, robotics and vision during eye movements.

Many of my main scientific achievements have been reviewed in text book and several reviews (for example: “Neuronal operation in the visual cortex”, ed. G. Orban, Springer-Verlag 1984 ; “Human Brain Elettrophysiology”, ed. Regan, Elsevier, 1989 ; “Perception”, ed. R. Sekuler e R. Blake, Knopf, New York, 1985; “The neuronal basis of visual function”, ed. Leventhal, Macmillan Press, 1991 and several more recent chapters and text books).

Several commentaries have been written on some of my work in major journals like *Nature* (“News and Views”) Braddick (Vol. 320, pp. 680-681,1986), Morgan (Vol 371, pp. 473, 1994) Miller e Bockisch (Vol386, pp. 550-551, 1997); on *Current Biology* by Husain, M. & Jackson, S. R. (*Curr Biol* **11**, R753-5, 2001); on “News and Views” of *Nature Neuroscience* by Eagleman (July 2005); in the “Book Review” section of *Science* by Prof. R. Shapley (Vol. 256, pag. 1837, 1992) and also in general public science magazines like Focus, KOS, Galileo, Quaderni Molisani, Iprovisione and L’Ala.

Some of the scientific results and the developed technology have been transferred and applied to the field of bio-technology (eg. the equiluminant VEP) and to computer vision (the edge detection and motion detection algorithms).

Below I give a very brief account of the major contributions. The numbers refer to publications list enclosed to the CV. Some more recent interests are omitted for brevity.

### **Perception during eye-movements**

A long-standing problem for visual perception, that has occupied much of my research career, is why the world remains stable in the face of continual eye-movements called saccades (spontaneous ballistic movements occurring about three times per second). There are two broad aspects to the problem: why the image motion generated by the eye movement is not sensed; and how is a stable allocentric map maintained. Psychophysical studies by my group suggest that motion produced by saccadic motion is not sensed because it is actively suppressed at the time of saccades [47]; however, the suppression is not total, but limited to the magnocellular pathway [47,56, 60, 74,75, 96], the pathway primarily responsible for motion perception.

An even more challenging problem is how the world remains stable in the face of shifts in the retinal images brought about by saccades. We have shown that despite this apparent perceptual stability, around the time of saccades briefly displayed objects are systematically mislocated in a complex way. Objects tend to be seen near the saccadic target (the intended landing point of the saccade), causing a strong compression of visual space [64, 66, 77, 83, 89]. These psychophysical studies have now been replicated in several laboratories, and very strong parallels have been found in the behaviour of cell populations. The exact purpose of this compression is not yet clear, but it is almost certainly instrumental in facilitating the smooth transition from one fixation to another. Interestingly, the compression occurs only for perceptual judgements, and is not present when subjects indicate their responses by blind pointing [81, 93], reinforcing suggestions for separate maps for perception and action. More recent work suggests that there may also be a parallel compression in time during saccades [90]: the strong linked alteration of space and time is suggesting an interesting mathematical model to explain the neuronal basis of the compression and the perceptual stability despite the continual eye movements.

Our normal experience is the information derived from one fixation is transferred to the next, but how and where do we construct a stable *spatiotopic* representation of the world centered in real-world external coordinates from the successive retinal “snapshots” of each fixation it is still largely unknown. Recently psychophysical studies by my group have shown that linear integration occurs for motion signals that are individually below threshold and are presented at the same location in the external space, but at different eccentricities [85]. Using fMRI, we went on demonstrating that the retinotopic representation of motion becomes transformed into the *spatiotopic* representation that we perceive, anchored in stable real-world coordinates, at level of the area MT+ (an early cortical region specialized in the analysis of motion) [107]. Another example of spatiotopic neuronal mechanisms is the demonstration of spatially specific adaptation of event-time [106], a clear demonstration that the flow of time is constantly measured in parallel by a multitude of neuronal clocks linked to the spatial coordinate.

### **Perception of visual features**



An important and long-studied problem for form perception is how the visual system detects and identifies important visual features, such as lines and edges (and illusory features, such as *Mach Bands* [21, 29]). I developed a simple but biologically plausible model of feature detection based on “local energy” [24, 26, 41, 42, 55], that successfully detects and identifies lines and edges in natural images, with high tolerance to noise, and which successfully predicts human performance and a series of visual illusions, new and old [48, 65], as well as our ability to perceive face symmetry [84] and transparency. More recent experiments using fMRI have revealed the neuronal circuits in human brain that may mediate the computation of the local energy [92].

### **Motion Perception**

Together with David Burr, who was the first to understand the importance of the “spatio-temporal receptive field” for motion detectors, a concept lying at the heart of many models of motion, we have studied how the form of moving objects is analyzed, veridically, without significant smear and the parameters of the RF for early visual motion analysis [18, 19, 36, 67, 95]. We have also demonstrated the existence in the human visual system of mechanisms specialised for the complex “optic flow” motion (including radial and circular motion), by both psychophysical [54, 73, 85] and imaging techniques [76]. These detectors parallel strongly the neurons that have been described in visual area MSTd of the macaque monkey. Other similar work characterised the properties of “biological motion” [70].

### **Cortical inhibition and its functional significance**

One of the primary characteristics of visual cortical neurons is that they are selective for stimulus orientation. Together with David Burr, I demonstrated that the neurons do not encode orientation independently of each other, but exert a mutual inhibition on each other. This was first demonstrated in cats, then in humans, using evoked potential techniques [7,25]. We also showed that the inhibition plays an important functional role in helping to delineate perceptual contours [8]. Furthermore, we showed that the inhibitory interaction in infants are not present at birth but develop at around 9 months of age [15]. We studied directly the GABAergic circuitry during development in the LGN and visual cortex of kitten and their plasticity and recover after variable periods of monocular deprivation [10, 11, 22, 34, 35] and in adult human after short term deprivation [170] using ultra-high field MR-SPECT. At present, 20 years after these first demonstrations, it is well accepted that the development of GABAergic inhibition is a crucial factor in delimiting the critical period of plasticity.

Other electrophysiological studies in cat and monkey have addressed the neuronal selectivity of primary and intra-parietal neurons in cat [2, 3, 20] and the colour selectivity of monkey retinal ganglion cells and their contribution to P-ERG in monkey and humans [49, 50].

### **Color Vision**

The major goal of these studies was the characterization of the development of colour vision in infants, aiming to determine the possible difference in maturation of the magno- and parvocellular pathways [30, 44, 59]. Contrary to expectations, we demonstrated that the colour pathways follow a rapid development, once luminance contrast sensitivity approaches adult levels. To achieve these goals it was necessary to develop a new Visual Evoked Potential technique that could isolate specifically the chromatic response. The technique has been

developed commercially, and is currently used as early diagnostic tool in many clinical units. My research group has used it to demonstrate a higher susceptibility of the magno-cellular pathways and/or of the dorsal stream with age in normal subjects [39, 57], in neglect patients [52], in the reorganization of brain function in infants with cerebral lesions [72].

Other studies on color vision have characterized the spatial [53, 58] and temporal properties [43, 69] of early neuronal mechanisms, and examined how those are differentially modulated by attention [79, 82, 87].

### **Plasticity in adult and child vision revealed by brief monocular deprivation**

We have recently devised an innovative technique that reveals an unexpectedly high degree of plasticity for ocular dominance in adult humans [132, 167, 170]: after only 2.5 hours of monocular eye-patching, *binocular rivalry* – a process thought to rely heavily on inhibitory mechanisms – becomes biased *in favour of the deprived eye*. The effect can persist for up to three hours, longer than the deprivation period. Two aspects of this study are extremely surprising. The first is the longevity of the effect, lasting more than 3 hours for chromatic gratings, longer than the deprivation period. This distinguishes the effect from the standard forms of contrast adaptation, which typically asymptote after a few seconds. The other surprising aspect is that the bias is *in favour* of the deprived eye. Monocular deprivation in animals always results in reduction of the effectiveness of the deprived eye, reflecting reduced thalamic afferent connections, leading to changes cortical ocular dominance. That brief periods of deprivation have the opposite effect in adult cortex is fascinating, implicating different forms of plasticity or different mechanisms in the early stages of plasticity.

## Publications

(Some downloadable: <http://www.pisavisionlab.org/index.php/people/faculty/morrone>)

- 1 Maffei, L., Morrone, M.C., Pirchio, M. & Sandini, G. (1979) A perceptual phenomenon and its neurophysiological correlate. *Perception* **8** 43-46.
- 2 Maffei, L., Morrone, M. C., Pirchio, M. & Sandini, G. (1979) Response of visual cortical cells to periodic and non-periodic stimuli. *J. Physiol.* **296** 27-47.
- 3 Hoffmann, K.P., Morrone, C. & Reuter, J.H. (1980) A comparison of the response of simple cells in the LGN and visual cortex to bar and noise stimuli in cat. *Vision Research* **20** 771- 777.
- 4 Burr, D.C., Morrone, M.C. & Maffei, L (1981) Intracortical inhibition prevents simple cells from responding to textured patterns. *Exp. Brain Res.* **43** 455-458.
- 5 Cattaneo, A., Maffei, L. & Morrone, M. C. (1981) Patterns in the discharge of simple and complex visual cortical cells. *Proc. Roc. Soc. (Lond.) B* **212** 279-297.
- 6 Cattaneo, A., Maffei, L. & Morrone, C. (1981) Two firing patterns in the discharge of complex cells encode different attributes of the visual stimulus. *Exp Brain Research* **43** 115-118.
- 7 Morrone, M.C., Burr, D.C. & Maffei, L. (1982) Functional implications of cross-orientational inhibition of cortical visual cells. Part I Neurophysiological evidence. *Proc. Roy. Soc. (London)* **B216** 335-354.
8. Morrone, M.C., Burr, D.C. & Ross, J. (1983) Added noise restores recognition of coarse quantised images. *Nature* **305** 226-228.
9. Morrone, M.C., Burr, D.C. & Ross, J. (1984) Noise and recognizability of coarse quantized images. *Nature* **308** 214.
10. Berardi, N. & Morrone, M. C. (1984) The role of  $\gamma$ -aminobutyric acid mediated inhibition in the response properties of cat lateral geniculate nucleus neurones. *J. Physiol.* **357** 505- 523.
11. Berardi, N. & Morrone, M.C. (1984) Development of  $\gamma$ -aminobutyric acid mediated inhibition of X cells of the cat lateral geniculate nucleus. *J. Physiol.* **357** 525-537.
12. Burr, D.C., Ross, J. & Morrone, M.C. (1985) Local regulation of luminance gain *Vision Res.* **25** 717-728.
13. Di Stefano, M, Morrone, M.C. & Burr, D.C. (1985) Spatial acuity of cells of the post medial lateral suprasylvian gyrus *Brain Res.* **331** 382-385.
14. Burr, D.C., Ross, J. & Morrone, M.C. (1986) A spatial illusion from motion rivalry. *Perception* **15** 59-66.
15. Morrone, M.C. & Burr, D.C. (1986) Evidence for the existence and development of visual inhibition in humans. *Nature* **321** 235-237.
16. Burr, D.C., Morrone, M.C. & Ross, J. (1986) Local and global visual analysis. *Vision Res.* **26** 749-757.
17. Hayes, T., Morrone, M.C. & Burr, D.C. (1986) Recognition of band-pass filtered positive and negative band-pass filtered images. *Perception* **15** 595-602.

18. Burr, D.C., Ross, J. & Morrone, M.C. (1986) Seeing objects in motion *Proc. Roy. Soc. (Lond)* **B227** 249-265.
19. Burr, D.C., Ross, J. & Morrone, M.C. (1986) Smooth and sampled motion. *Vision Research* **26** 643-652.
20. Morrone, M.C., Di Stefano, M. & Burr, D. (1986) Spatial and temporal selectivity of neurones of the lateral suprasylvian gyrus of the cat. *J. Neurophysiol.* **56** 969-986.
21. Morrone, M.C., Ross, J., Burr, D.C. & Owens, R. (1986) Mach bands are phase dependent. *Nature* **324** 250-253.
22. Morrone, M.C., Burr, D.C. & Speed, H.D. (1987) Cross-orientation inhibition in cat is GABA mediated. *Exptl. Brain Res.* **67** 635-644.
23. Burr, D.C., Fiorentini, A. & Morrone, M.C. (1987) Electrophysiological correlates of positive and negative afterimages. *Vision Res.* **27** 201-207.
24. Morrone, M.C. & Owens, R. (1987) Feature detection from local energy. *Pattern Rec. Letters.* **1** 103-113.
25. Burr, D.C. & Morrone, M.C. (1987) Inhibitory interactions in the human visual system revealed by pattern evoked potentials. *J. Physiol. (Lond.)* **209** 1-21.
26. Morrone, M.C. & Burr, D.C. (1988) Feature detection in human vision: a phase-dependent energy model. *Proc. Roy. Soc.* **B 235** 221-245.
27. Morrone, M.C., Burr, D.C. & Spinelli, D. (1989) Discrimination of spatial phase in central and peripheral vision. *Vision Res.* **29** 433-445.
28. Burr, D.C., Morrone, M.C. & Spinelli, D. (1989) Evidence for the existence of bar and edge detectors in human vision. *Vision Res.* **29** 419-431.
29. Ross, J., Morrone, M.C. & Burr, D.C. (1989) The conditions for the appearance of Mach bands. *Vision Res.* **29** 699-715.
30. Morrone, M.C., Burr, D.C. and Fiorentini, A. (1990) Development of infant contrast sensitivity and acuity to chromatic stimuli *Proc Roy Soc B* **242** 134-139.
31. Burr, D.C. & Morrone, M.C. (1990) Edge detection in biological and artificial visual systems. In *Vision: coding and efficiency* (pp185-194) edited by Colin Blakemore, Cambridge University Press, Cambridge.
32. Burr, D.C. Morrone, M.C. & Fiorentini, A. (1991) Development of infant contrast sensitivity and acuity for coloured patterns. In *Advances in understanding visual processes.* pp 185- 188 (Edited by A. Valberg and B.B. Lee). Plenum Press, Berlin.
33. Fiorentini, A., Burr, D.C. & Morrone, M.C. (1991) Temporal characteristics of colour vision: VEP and psychophysical measurements. In *Advances in understanding visual processing.* pp 139-150 (Edited by A. Valberg and B.B. Lee). Plenum Press, Berlin.
34. Morrone, M.C., Speed, H.D. & Burr, D.C. (1991) Development of inhibitory interactions in kittens. *Visual Neuroscience* **7** 321-334.
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