



155

PROGRESS IN
BRAIN RESEARCH

Visual Perception

PART 2

Fundamentals of Awareness,
Multi-Sensory Integration and
High-Order Perception

EDITED BY

S. MARTINEZ-CONDE

S.L. MACKNIK

L.M. MARTINEZ

J.-M. ALONSO

P.U. TSE

PROGRESS IN BRAIN RESEARCH

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EDITED BY

S. MARTINEZ-CONDE

*Department of Neurobiology, Barrow Neurological Institute, Phoenix,
AZ 85013, USA*

S.L. MACKNIK

*Departments of Neurosurgery and Neurobiology, Barrow Neurological Institute, Phoenix,
AZ 85013, USA*

L.M. MARTINEZ

*Departamento de Medicina, Facultade de Ciencias da Saúde, Campus de Oza, Universidade da Coruña,
15006, A Coruña, Spain*

J.-M. ALONSO

Department of Biological Sciences, State University of New York – Optometry, New York, NY 10036, USA

P.U. TSE

Department of Psychological and Brain Sciences, Dartmouth College, Hanover, NH 03755, USA



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List of Contributors

- D. Alais, Department of Physiology and Institute for Biomedical Research, School of Medical Science, Auditory Research Laboratory, University of Sydney, Sydney, NSW 2006, Australia
- E. Aminoff, MGH Martinos Center for Biomedical Imaging, Harvard Medical School, 149 Thirteenth Street, Charlestown, MA 02129, USA
- S. Anstis, Department of Psychology, UCSD, 9500 Gilman Drive, La Jolla, CA 92093-0109, USA
- M. Bar, MGH Martinos Center for Biomedical Imaging, Harvard Medical School, 149 Thirteenth Street, Charlestown, MA 02129, USA
- P. Berbel, Instituto de Neurociencias de Alicante UMH-CSIC, Campus de San Juan, Apartado 18, 03550 San Juan de Alicante, Spain
- N.P. Bichot, McGovern Institute for Brain Research, Massachusetts Institute of Technology, Bldg. 46-6121, Cambridge, MA 02139, USA
- J.W. Bisley, Center for Neurobiology and Behavior, Columbia University, 1051 Riverside Drive, Unit 87, New York, NY 10032, USA
- S. Blau, Department of Neuroscience, Brown University, Providence, RI 02912, USA
- D. Burr, Dipartimento di Psicologia, Università degli Studi di Firenze, Via S. Nicolò, Florence, Italy and Istituto di Neuroscience del CNR, Via Moruzzi 1, Pisa 56100, Italy
- I.C. Cuthill, School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK
- B. de Gelder, Cognitive and Affective Neurosciences Laboratory, Department of Psychology, Tilburg University, PO Box 90153, Tilburg, 5000 LE, The Netherlands
- V.F. Descalzo, Instituto de Neurociencias de Alicante, Universidad Miguel Hernandez-CSIC, Apartado 18, 03550 San Juan de Alicante, Spain
- R. Desimone, McGovern Institute for Brain Research, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Bldg. 46-3160, Cambridge, MA 02139, USA
- M.J. Fenske, MGH Martinos Center for Biomedical Imaging, Harvard Medical School, 149 Thirteenth Street, Charlestown, MA 02129, USA
- E. Gallego, Department of Psychology, University of La Coruña, Campus de Elviña, La Coruña, 15071, Spain
- R. Gallego, Instituto de Neurociencias de Alicante UMH-CSIC, Campus de San Juan, Apartado 18, 03550 San Juan de Alicante, Spain
- J.V. Garcia-Velasco, Instituto de Neurociencias de Alicante UMH-CSIC, Campus de San Juan, Apartado 18, 03550 San Juan de Alicante, Spain
- M.E. Goldberg, Center for Neurobiology and Behavior, Columbia University, 1051 Riverside Drive, Unit 87, New York, NY 10032, USA
- J. Gottlieb, Center for Neurobiology and Behavior, Columbia University, 1051 Riverside Drive, Unit 87, New York, NY 10032, USA
- J.M. Groh, Center for Cognitive Neuroscience, Department of Psychology and Neuroscience, and Department of Neurobiology, Duke University, LSRC Rm B203, Durham, NC 27708, USA
- N. Gronau, MGH Martinos Center for Biomedical Imaging, Harvard Medical School, 149 Thirteenth Street, Charlestown, MA 02129, USA

- X. Huang, Keck Center, Department of Physiology, University of California, San Francisco, CA 94143-0444, USA
- S. Kastner, Department of Psychology, Center for the Study of Brain, Mind and Behavior, Princeton University, Green Hall, Princeton, NJ 08544, USA
- A. Kingstone, Department of Psychology, University of British Columbia, 2136 West Mall, Vancouver, BC V6T 1Z4, Canada
- S.P. MacEvoy, Department of Neurobiology, Duke University Medical Center, Durham, NC 27710, USA
- S.L. Macknik, Departments of Neurosurgery and Neurobiology, Barrow Neurological Institute, 350 W. Thomas Road, Phoenix, AZ 85013, USA
- H.K.M. Meeren, Cognitive and Affective Neurosciences Laboratory, Department of Psychology, Tilburg University, PO Box 90153, Tilburg, 5000 LE, The Netherlands
- L.G. Nowak, Centre de Recherche “Cerveau et Cognition”, CNRS-Université Paul Sabatier, 133 Route de Narbonne, 31062 Toulouse Cedex, France
- A. Oliva, Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Building 46-4065, Cambridge, MA 02139, USA
- M.A. Paradiso, Department of Neuroscience, Brown University, Providence, RI 02912, USA
- C.A. Párraga, Department of Experimental Psychology, University of Bristol, 8 Woodland Road, Bristol BS8 1TN, UK
- K.K. Porter, University of Alabama, School of Medicine, Birmingham, AL 35294, USA
- K.D. Powell, Laboratory of Sensorimotor Research, National Eye Institute, National Institutes of Health, Bethesda, MD 20892, USA
- R. Righart, Cognitive and Affective Neurosciences Laboratory, Department of Psychology, Tilburg University, PO Box 90153, Tilburg, 5000 LE, The Netherlands
- A.F. Rossi, Department of Psychology, Vanderbilt University, Nashville, TN 37203, USA
- N. Sagiv, Centre for Cognition and Neuroimaging, Brunel University, Uxbridge, Middlesex UB8 3PH, UK
- M.V. Sanchez-Vives, Instituto de Neurociencias de Alicante UMH-CSIC, Campus de San Juan, Apartado 18, 03550 San Juan de Alicante, Spain
- K.A. Schneider, Department of Psychology, Center for the Study of Brain, Mind and Behavior, Princeton University, Green Hall, Princeton, NJ 08544, USA
- G. Shalev, Department of Neuroscience, Brown University, Providence, RI 02912, USA
- S. Soto-Faraco, Hospital Saint Joan de Déu (Edifici Docent), C/Santa Rosa 39-57, Planta 4a, 08950 Esplugues de Llobregat, Barcelona, Spain
- C. Spence, Department of Experimental Psychology, University of Oxford, South Parks Road, Oxford OX1 3UD, UK
- L. Spillmann, Neurozentrum, University Hospital, Breisacher Street 64, 79106 Freiburg, Germany
- M. Stevens, School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK
- P. Stoerig, Institute of Experimental Psychology II, Heinrich-Heine-University, Building 23.03, Universitätsstr 1, D-40225 Dusseldorf, Germany
- M. Tamietto, Department of Psychology, University of Turin, Turin, Italy
- A. Torralba, Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology, 77 Massachusetts Avenue, 32-D462, Cambridge, MA 02139, USA
- T. Troscianko, Department of Experimental Psychology, University of Bristol, 8 Woodland Road, Bristol BS8 1TN, UK
- F. Valle-Inclán, Department of Psychology, University of La Coruña, Campus de Elviña, La Coruña 15071, Spain
- W.A.C. Van De Riet, Cognitive and Affective Neurosciences Laboratory, Department of Psychology, Tilburg University, P.O. Box 90153, Tilburg, 5000 LE, The Netherlands

- J. van Den Stock, Cognitive and Affective Neurosciences Laboratory, Department of Psychology, Tilburg University, PO Box 90153, Tilburg, 5000 LE, The Netherlands
- J. Ward, Department of Psychology, University College London, 26 Bedford Way, London WC1H 0AP, UK
- K. Wunderlich, Department of Psychology, Center for the Study of Brain, Mind and Behavior, Princeton University, Green Hall, Princeton, NJ 08544, USA

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General Introduction

“Visual Perception” is a two-volume series of Progress in Brain Research, based on the symposia presented during the 28th Annual Meeting of the European Conference on Visual Perception (ECVP), the premier transnational conference on visual perception. The conference took place in A Coruña, Spain, in August 2005. The Executive Committee members of ECVP 2005 edited this volume, and the symposia speakers provided the chapters herein.

The general goal of these two volumes is to present the reader with the state-of-the-art in visual perception research, with a special emphasis in the neural substrates of perception. “Visual Perception (Part 1)” generally addresses the initial stages of the visual pathway, and the perceptual aspects than can be explained at early and intermediate levels of visual processing. “Visual Perception (Part 2)” is generally concerned with higher levels of processing along the visual hierarchy, and the resulting percepts. However, this separation is not very strict, and several of the chapters encompass both early and high-level processes.

The current volume “Visual Perception (Part 2) — Fundamentals of Awareness, Multi-Sensory Integration and High-Order Perception” contains 18 chapters, organized into 4 general sections, each addressing one of the main topics in vision research today: “The role of context in recognition”; “From perceptive fields to Gestalt. A tribute to Lothar Spillmann”; “The neural bases of visual awareness and attention, and “Crossmodal interactions in visual perception”. Each section includes a short introduction and four to five related chapters. The topics are tackled from a variety of methodological approaches, such as single-neuron recordings, fMRI and optical imaging, psychophysics, eye movement characterization and computational modeling. We hope that the contributions enclosed will provide the reader with a valuable perspective on the current status of vision research, and more importantly, with some insight into future research directions and the discoveries yet to come.

Many people helped to compile this volume. First of all, we thank all the authors for their contributions and enthusiasm. We also thank Shannon Bentz, Xoana Troncoso and Jaime Hoffman, at the Barrow Neurological Institute, for their assistance in obtaining copyright permissions for several of the figures reprinted here. Moreover, Shannon Bentz transcribed Lothar Spillmann’s lecture, and provided general administrative help. Xoana Troncoso was heroic in her effort to help us to meet the submission deadline by collating and packing all the chapters, and preparing the table of contents. We are indebted to Johannes Menzel and Maureen Twaig, at Elsevier, for all their encouragement and assistance; it has been wonderful working with them.

Finally, we thank all the supporting organizations that made the ECVF 2005 conference possible: Ministerio de Educación y Ciencia, International Brain Research Organization, European Office of Aerospace Research and Development of the USAF, Consellería de Educación, Industria e Comercio-Xunta de Galicia, Elsevier, Pion Ltd., Universidade da Coruña, Sociedad Española de Neurociencia, SR Research Ltd., Consellería de Sanidade-Xunta de Galicia, Mind Science Foundation, Museos Científicos Coruñeses, Barrow Neurological Institute, Images from Science Exhibition, Concello de A Coruña, Museo Arqueolóxico e Histórico-Castillo de San Antón, Caixanova, Vision Science, Fundación Pedro Barrié de la Maza, and Neurobehavioral Systems.

Susana Martinez-Conde

Executive Chair, European Conference on Visual Perception 2005

On behalf of ECVF 2005's Executive Committee: Stephen Macknik, Luis Martinez,
Jose-Manuel Alonso and Peter Tse

SECTION I

The Role of Context in Recognition

Introduction

Predator or prey? Big or little? City skyline or the latest line of kitchen cabinetry? These questions may seem random, but it all depends on the context in which they are posed. In fact, they are all questions that become coherent and can be answered only if the context is known. Well, the skyline/cabinetry question may still seem out of the blue, but it will all snap into focus as you read the following four chapters that explore how visual object recognition critically depends on the context that the objects lie in, and their relevance to the observer.

Fenske, Aminoff, Gronau, and Bar start the section with a chapter that discusses how top-down facilitation modifies the differential contributions

of object-based and context-based object recognition. Oliva and Torralba discuss the importance of context to our ability to recognize the gist of a scene at a single glance: without considering context, we might not be able to tell apart the city skyline from the kitchen cabinets. De Gelder, Meeren, Righart, Van den Stock, van de Riet, and Tamietto show how context also plays a critical role in face recognition. Stevens, Cuthill, Parraga, and Troscianko discuss how disruptive coloration in camouflage serves to conceal objects within the context of their surroundings.

Stephen L. Macknik

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Top-down facilitation of visual object recognition: object-based and context-based contributions

Mark J. Fenske, Elissa Aminoff, Nurit Gronau and Moshe Bar*

MGH Martinos Center for Biomedical Imaging, Harvard Medical School, 149 Thirteenth Street, Charlestown, MA 02129, USA

Abstract: The neural mechanisms subserving visual recognition are traditionally described in terms of bottom-up analysis, whereby increasingly complex aspects of the visual input are processed along a hierarchical progression of cortical regions. However, the importance of top-down facilitation in successful recognition has been emphasized in recent models and research findings. Here we consider evidence for top-down facilitation of recognition that is triggered by early information about an object, as well as by contextual associations between an object and other objects with which it typically appears. The object-based mechanism is proposed to trigger top-down facilitation of visual recognition rapidly, using a partially analyzed version of the input image (i.e., a blurred image) that is projected from early visual areas directly to the prefrontal cortex (PFC). This coarse representation activates in the PFC information that is back-projected as “initial guesses” to the temporal cortex where it presensitizes the most likely interpretations of the input object. In addition to this object-based facilitation, a context-based mechanism is proposed to trigger top-down facilitation through contextual associations between objects in scenes. These contextual associations activate predictive information about which objects are likely to appear together, and can influence the “initial guesses” about an object’s identity. We have shown that contextual associations are analyzed by a network that includes the parahippocampal cortex and the retrosplenial complex. The integrated proposal described here is that object- and context-based top-down influences operate together, promoting efficient recognition by framing early information about an object within the constraints provided by a lifetime of experience with contextual associations.

Keywords: object recognition; top-down; feedback; orbitofrontal cortex; low spatial frequencies; visual context; parahippocampal cortex; retrosplenial cortex; visual associations; priming

Successful interaction with the visual world depends on the ability of our brains to recognize visual objects quickly and accurately, despite infinite variations in the appearance of objects and the settings in which they are encountered. How does the visual system deal with all of this information in such a fluent manner? Here we consider the cortical mechanisms and the type of information

that they rely on to promote highly efficient visual recognition through top-down processes. The evidence we review, from studies by our lab and others, suggests that top-down facilitation of recognition can be achieved through an object-based mechanism that generates predictions about an object’s identity through rapidly analyzed, coarse information. We also review evidence that top-down facilitation of recognition can be achieved through the predictive information provided by contextual associations between an object or scene

*Corresponding author. Tel.: +1-617-726-7467; Fax: +1 617-726-7422; E-mail: bar@nmr.mgh.harvard.edu