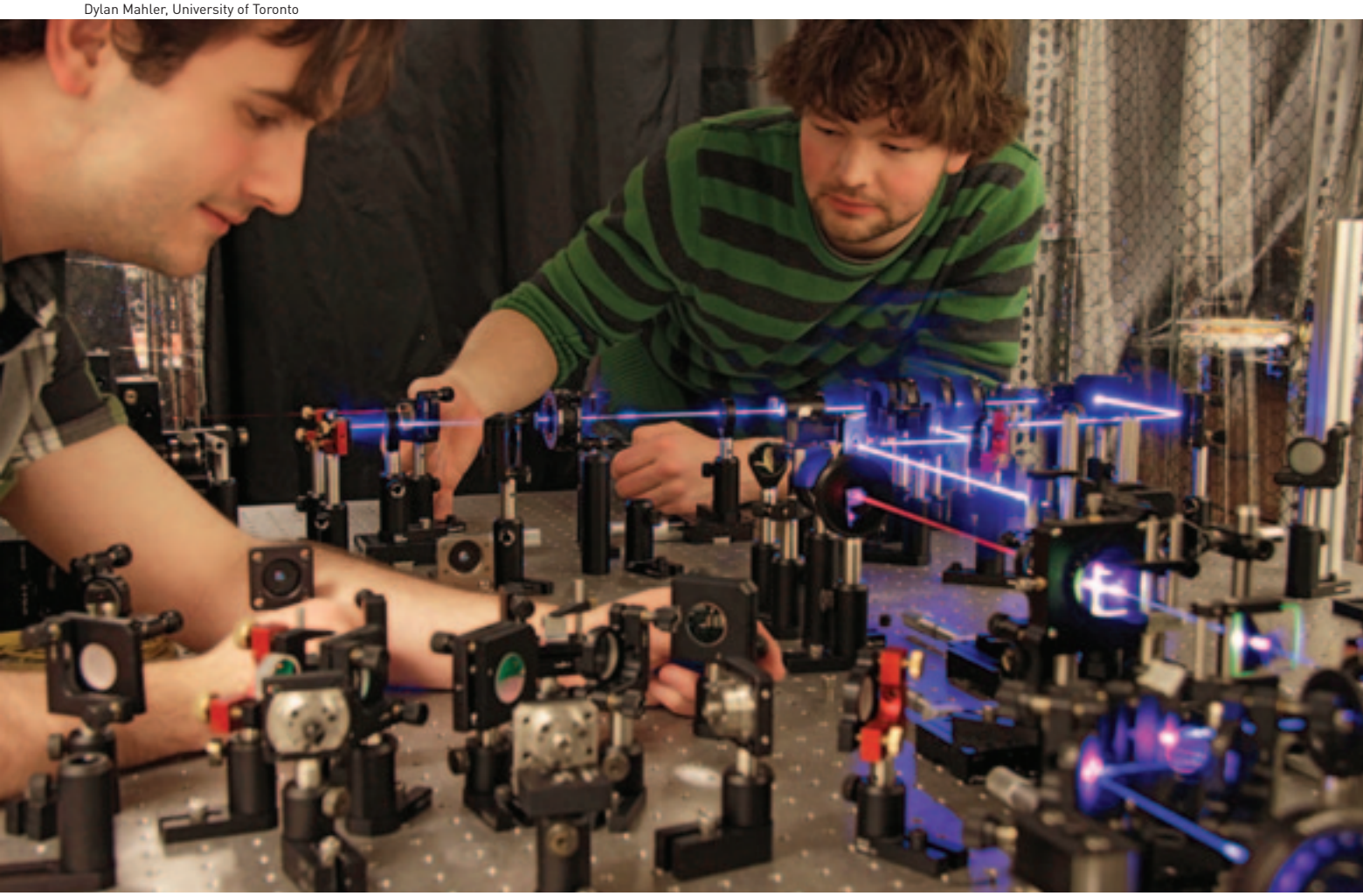
Dylan Mahler, University of Toronto



Dylan Mahler (left) and Lee Rozema prepare pairs of entangled photons to study the disturbance the photons experience after they are measured.

Heisenberg Certainty

Researchers gather evidence that Heisenberg's famous principle is wrong.

As anyone who has studied quantum mechanics knows, the Heisenberg Uncertainty Principle states that it is impossible to precisely identify the location and momentum of an electron at the same time. Because measurements disturb the system, increased certainty in the first measurement leads to greater uncertainty in the second. Werner Heisenberg formulated the math behind this concept at the beginning of the 20th century. Scientists later generalized the equations to capture intrinsic uncertainty in quantum systems regardless of measurement, but the principle is still loosely applied to the original measurement-disturbance relationship. Now, researchers from the University of Toronto have gathered the most direct experimental evidence that Heisenberg's original formulation was wrong. They presented their work at OSA's annual Frontiers in Optics meeting in Rochester this October.

The researchers found a way around this quantum mechanical catch-22 by using techniques from quantum measurement theory to sneak non-disruptive peeks of the photons before their polarization was measured. By comparing thousands of before-and-after views of the photons, they revealed that their precise measurements disturbed the system much less than predicted by the original Heisenberg formula. The results suggest that a new measurement-disturbance relationship, mathematically computed by physicist Masanao Ozawa at Nagoya University in Japan in 2003, is more accurate.

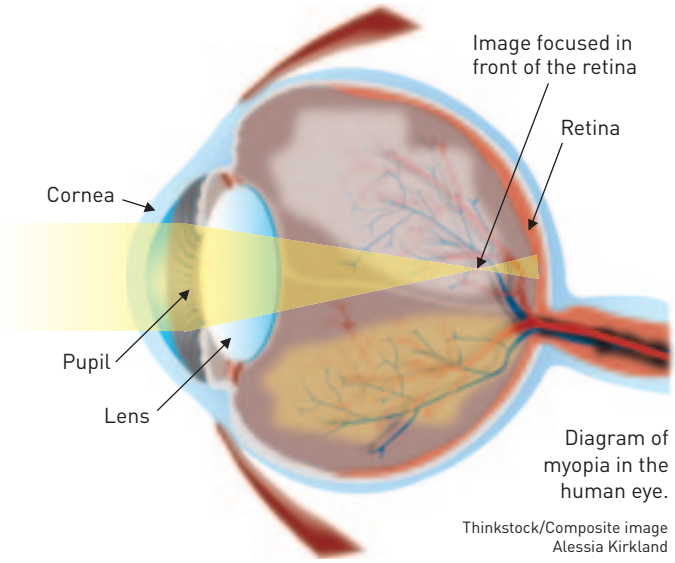


Diagram of myopia in the human eye.

Thinkstock/Composite image Alessia Kirkland

A Potential Cure for Myopia

Using contact lenses to reshape the eye

Nearsightedness, or myopia, affects up to 90 percent of children in some parts of Asia and typically progresses with age. It develops when the eye is too long, making it difficult to focus light from distant objects on the retina. Standard prescription lenses can correct the defocus but do not cure nearsightedness, and they do not slow progression rates as children grow. But recent work by David Troilo and colleagues at the State University of New York College of Optometry (U.S.A.) offers a potential cure for myopia by using specialty contact lenses that coax the eye to grow in a way that can correct vision while reducing myopia progression. They presented their work at October's Frontiers in Optics meeting.

These special contact lenses alter how light is focused in the peripheral retina and induce changes in growth that help reshape the eye. Regular glasses or contact lenses create slight farsightedness in the peripheral retina. This peripheral farsightedness may worsen myopia in children because their eyes grow to move the retina to where the light is focused, lengthening the eye even further. The experimental lenses use different focal powers within a single lens: either alternating focal powers across the lens or confined to the outer edge. Experiments with the new lenses found that they changed eye growth and refractive state, or focus, in a predictable way—reducing the elongation of the eye that causes myopia progression.

Spider Silk as an Optical Material

Who knew that spider silk, long studied for its tensile strength, could also act like an optical fiber? French physicists are investigating its light-carrying properties for on-chip integration with other photonic structures. They presented their work at the Frontiers in Optics meeting in October.

Nolwenn Huby of the CNRS Institut de Physique de Rennes (France) and her group research the optical properties of the silk fiber spun by *Nephila clavipes*, a spider found in the warmer regions of North and South America. The female *N. clavipes* spins webs up to 1 m in diameter.

Huby's group tested the light propagation ability of the 5-μm-wide fibers, which have a refractive index of about 1.55, and found attenuation of 20 ± 10 dB/cm. Next, the researchers verified the optical coupling of two silk fibers separated by a 15-μm gap.

Finally, the researchers used the silk to connect three disk reservoirs etched by UV lithography onto a silicon-based substrate. When they sent a laser beam through these structures, a microbeam profiler confirmed that they were properly coupled. The results hold great promise for future applications in biophotonics. —*Patricia Daukantas*

Courtesy of Michel Pézolet

N. clavipes

The silk of the spider *Nephila clavipes* is **six times** as strong as steel. It is being investigated as an optical material.

POLICY

2015: International Year of Light

OSA joins international optics community in push for U.N. declaration.

The United Nations Educational, Scientific and Cultural Organization's (UNESCO) is adopting a resolution to declare 2015 the International Year of Light. The Executive Board, with members from Ghana, Mexico, New Zealand and the Russian Federation, unanimously passed the resolution in October at its 190th session in Paris. More than two dozen other nations signed on in support. The European Physical Society has been working with partners and supporters, including OSA, to gain approval by the United Nations to make this declaration. The adoption last week by UNESCO paves the way for approval by the full U.N. general assembly.

The purpose of the International Year of Light is to communicate the global importance of light and optical technologies in our lives, for our futures and for the development of society. The program will consist of coordinated activities in science, education and development. The year 2015 marks a number of important optics anniversaries: It will be 200 years since Augustin-Jean Fresnel's seminal paper introducing the wave nature of light, 150 years since James Clerk Maxwell's work on electromagnetism, and 100 years since Einstein included the speed of light in his equations of general relativity.

Red (635 nm), green (532 nm), and blue-violet (445 nm) lasers.

Wikimedia Commons

The first step in the process occurred in November 2011 when the General Assembly of the International Union of Pure and Applied Physics passed a resolution supporting the program. As a result, the proposal then went on the agenda for the recent UNESCO session in Paris. The last official step is to formally propose the resolution to the entire U.N. General Assembly, which will make a final declaration. This is expected to happen in late 2013.

Happy Birthday to **Sir Isaac Newton**, who was born on 25 December 1642.

tweeted

Brandon Rodenburg @punk_physicist

Search for the Higgs highlights the fact that negative results are also important for science (e.g., setting limits on reality etc) #FiO12

Bill Gross @Bill_Gross

If #Starbucks had wifi connections that reached 5 miles, then more than HALF the U.S. would have free wifi!

Elizabeth Cloos @efcloos

As scientists we need to communicate the economic impact of our research to the public and to our congressmen. #FiO12

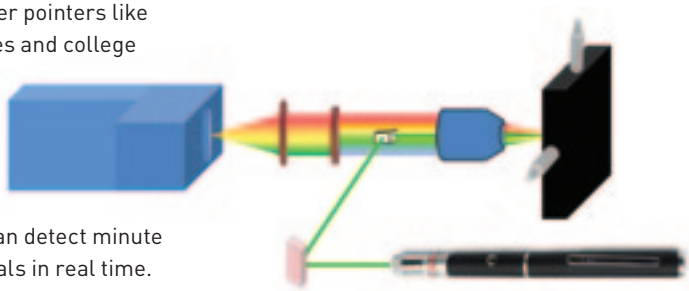
Tanya Monro @tanya-monro

I love running into collaborators at conferences around the world. It's like being part of a big extended scientific family. #joysofdoingscience

Using Laser Pointers for Chemical Sensing

With ordinary green laser pointers like the ones used in offices and college lecture halls, a research team from Ben Gurion University of the Negev (Israel) has developed a new and highly portable Raman spectrometer that can detect minute traces of hazardous chemicals in real time. As they reported at the Frontiers in Optics meeting, the new sensor's compact design makes it an excellent candidate for rapid field deployment to disaster zones and areas with security concerns.

The researchers brought this capability down to size by constructing their Raman spectrometer using a low-power, inexpensive commercial green laser pointer. The green laser's relatively short wavelength helped to improve the detection of the inherently weak Raman signal. The spectrometer also has the capability to first scan the entire sample optically, sweeping from side to side, to locate individual particles of interest—a task usually performed by large and cumbersome Raman microscopes.



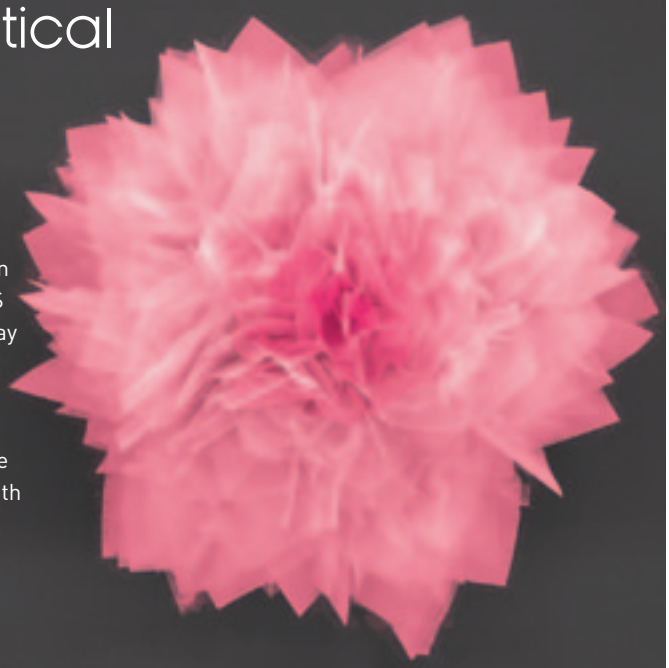
Schematic of Raman spectrometer, including a laser pointer, dichroic mirror, prism, objective, x,y motorized translational stage, long wavepass edge filter, lens and a detector (spectrometer/intensified charge-coupled device).

Courtesy of Ilana Bar, Ben Gurion University of the Negev

"With proper investment, this system could be deployed quite quickly as a consumer product," said Ilana Bar, a researcher with the department of physics at Ben-Gurion University of the Negev in Israel.

Pretty Practical

Researchers from North Carolina State University (U.S.A.) have created "nano-flowers" out of germanium sulfide (GeS). They have petals 20-30 nm thick with an enormous surface area (ACS Nano **6**, 8868). This shape may be ideal for energy storage applications since it allows for the maximum amount of semiconductor material to be made available to interact with light. This technology could increase capacity for solar cells, lithium-ion batteries and supercapacitors.
—Sarah Michaud



C. Li et al. ACS Nano **6**, 8868 (2012). ©2012 American Chemical Society

INDUSTRY

Scotland Leads U.K. in Physics-based Business

A new report by the Institute of Physics finds that Scotland has proportionately more physics-based businesses powering its economy than neighboring nations. Such businesses employ a total of 4.6 percent of the Scottish workforce, contributing 9.8 percent of the total Scottish economic output. Physics-based sectors contributed proportionately 10 percent more direct gross value added to the Scottish economy between 2005 and 2010 compared to 8.5 percent of the total U.K. average over the same period.

Despite the recession, the contribution of physics-based business sectors to the Scottish economy has grown by £1 billion since 2005 to £8.5 billion in 2010. This is more than the finance sector, which contributes £7 billion, and tourism, which contributes £2.9 billion. Expanding the numbers to include indirect effects from supply chains and downstream spending, physics-based sectors account for a total of £12.5 billion of Scottish economic output and 184,000 jobs. The full report can be viewed at www.iopscotland.org. —*Valerie Coffey*

TRUMPF/David Franck

Part of TRUMPF's headquarters in Ditzingen.

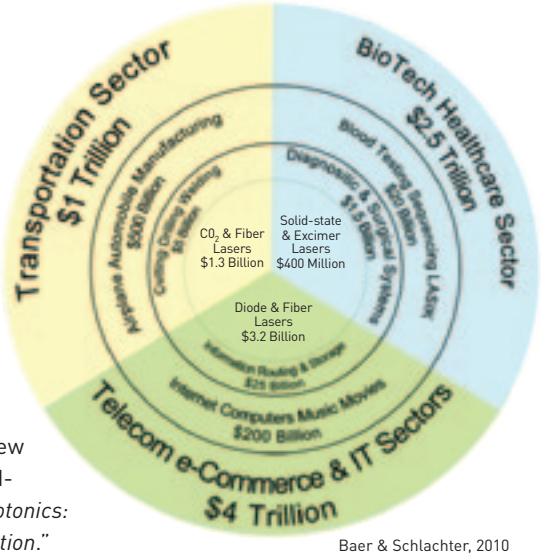
Trumpf Group Achieves Record Sales

The Trumpf Group (Ditzingen, Germany) recently reported the highest sales in its corporate history, and it predicted continued slight growth for the coming fiscal year despite the gradual economic slowdown.

The manufacturer of machine tools, laser and medical technology reported sales of €2.33 billion for the fiscal year ending 30 June 2012. This is an increase of 15 percent compared to the previous year's sales of €2.02 billion. President Nicola Leibinger-Kammüller said that Trumpf benefited from customers catching up on investments that were postponed during the recession. She added that the company's flexible production system allowed them to adjust to the increased demand, enabling a gain in global market share in spite of difficult economic times. —*Valerie Coffey*

Economic Impact of the LASER

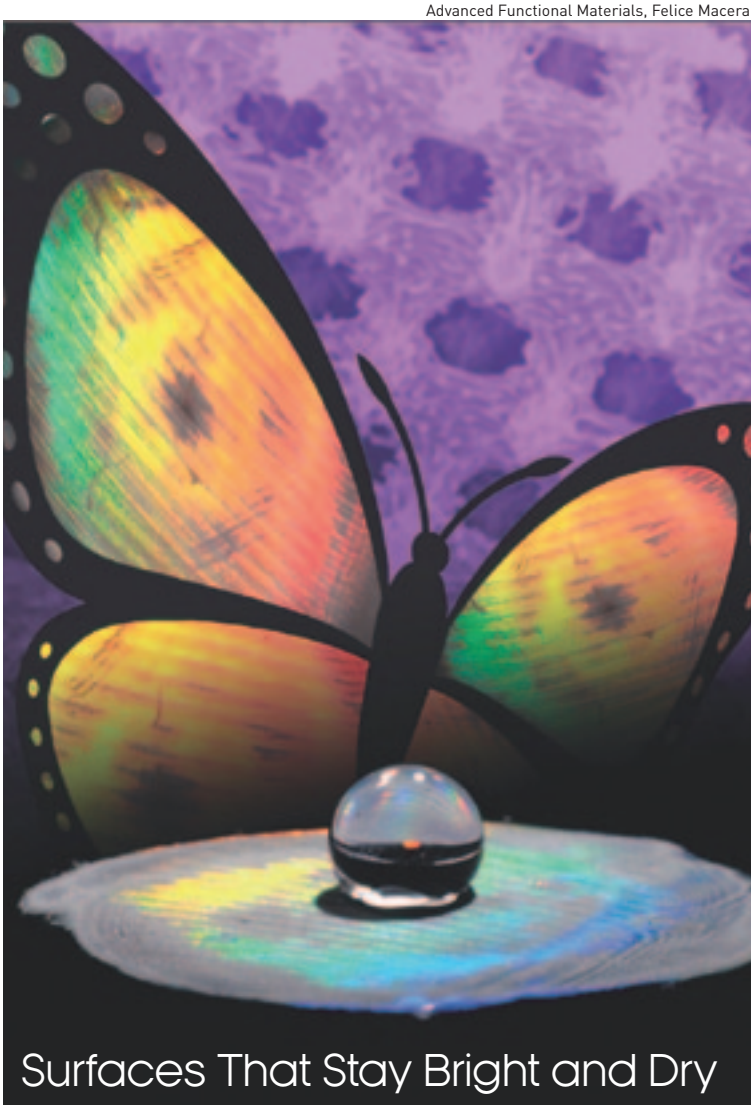
The direct sales of laser equipment greatly affects three economic sectors in the United States: transportation, biomedical and telecommunications. Tom Baer used this graphic at the Frontiers in Optics meeting to explain the importance of optical technology to the U.S. economy; it was part of a discussion about the new report by the U.S. National Academies of Sciences, *"Optics & Photonics: Essential Technologies for our Nation."*



Baer & Schlachter, 2010

Eadweard Muybridge's famous "Horse in Motion" marked the beginning of **high-speed photography** 134 years ago.

Advanced Functional Materials, Felice Macera



Surfaces That Stay Bright and Dry

Butterfly wings were the inspiration for creating 3-D photonic crystals: They both appear brightly colored because they diffract light and strongly repel water. Shu Yang's research group at the University of Pennsylvania (U.S.A.) developed a simple method for creating similar structures using lithography. The surfaces are made hydrophobic when they are treated with a poor solvent that roughens the surface enough to repel water but not enough to change the photonic bandgap in the IR (Adv. Funct. Mater. **22**, 2980). This surface treatment could allow solar cells to remain cleaner—and thus more efficient. *—Yvonne Carts-Powell*

BOOK REVIEWS

A Student's Guide to Vectors and Tensors

Daniel Fleisch, Cambridge University Press, 2011; $75.00 (hardcover), $28.99 (paperback).

This book is a concise teaching aid devoted to vector analysis and tensors. It is intended as a supplement to undergraduate physics courses such as mechanics and electromagnetism. Each chapter ends with a set of problems whose interactive solutions can be found on a website. This is both helpful and innovative. *—Albert C. Claus*

Principles of Laser Spectroscopy and Quantum Optics

Paul R. Berman and Vladimir S. Malinovsky, Princeton University Press, 2010; $95.00 (hardcover).

Principles of Laser Spectroscopy and Quantum Optics is a high-quality, well-written addition to the literature of modern optics. The title accurately describes the substantial contents, though the subject matter is actually narrower than might at first be inferred. As the authors make clear in the introduction, it's all about atoms. Although many other developments are taking place in the study of molecular systems, cavities and nanoparticles, this volume focuses on atomic response. *—David L. Andrews*

Manipulating Quantum Structures Using Laser Pulses

Bruce W. Shore, Cambridge University Press, 2011; $120.00 (hardcover).

Advanced undergraduates and researchers will find that this remarkable volume offers a clear approach to the theoretical basis of coherent interactions between light and matter on the quantum scale. Although it will be accessible to students, perhaps scientists will be the greater beneficiaries of the author's prodigious efforts in making this body of knowledge available. *—K. Alan Shore*

Patricia Daukantas, Yvonne Carts-Powell and Valerie Coffey are freelance science writers who specialize in optics and photonics. Sarah Michaud is OPN's associate editor.

Optical Remote Sensing: Advances in Signal Processing and Exploitation Techniques

Saurabh Prasad, Lori M. Bruce and Jocelyn Chanussot (eds.), Springer, 2011; $179.00 (hardcover).

This excellent reference focuses on advances in signal processing and exploitation techniques for optical remote sensing with a collection of state-of-the art algorithms for hyperspectral and multispectral imaging technologies. It is intended for advanced users, particularly graduate students and image scientists specializing in the field of optical remote sensing. —*Axel Mainzer Koenig*

How Vision Works: The Physiological Mechanisms Behind What We See

Nigel Daw, Oxford University Press, 2012; $99.99 (hardcover).

The author distills the essence of the psychology, anatomy and physiology of vision in fewer than 300 pages. Chapters include multiple color illustrations and end with the author's selection of the most relevant papers and books, including current research and 19th century classics. The intended audience includes graduate and advanced undergraduate students, as well as researchers looking for a unified view of vision issues without the bulk of more encyclopedic sources. —*Bogdan Hoanca*

Eye Tracking: A Comprehensive Guide to Methods and Measures

Kenneth Holmqvist, Marcus Nystrom, Richard Andersson, Richard Dewhurst, Halszka Jarodzka and Joost van de Weijer, Oxford University Press, 2011; $150.00 (hardcover).

This comprehensive text provides a review of eye tracking methodology. About 1,000 bibliographical references and an index are included at the end of the book. Readers will find that eye-tracking research is versatile, and it is easy and fun to construct new measures. It is a great resource for anyone considering research that involves eye-tracking. —*Reva Garg*

ONLINE EXTRA

Visit www.osa-opn.org for additional book reviews.

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