Helmholtz Herald
Quarterly letter of the Helmholtz Institute

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{Content}:

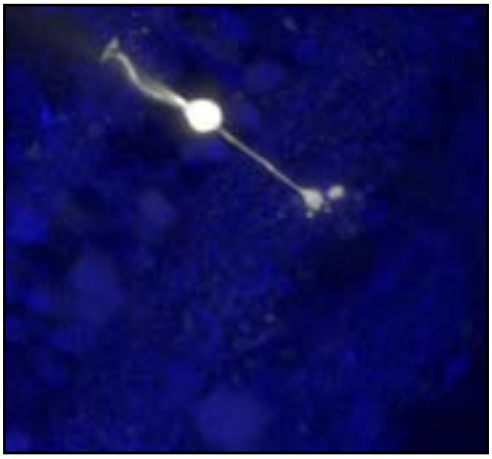
Martin Lankheet in Nature

Martin Lankheet of the Functional Neurobiology group at Utrecht University succeeded in tracking light signals throughout the retina and in cooperation with the Fred Rieke lab at Washington University published the results in the October 4 2007 edition of Nature.

The Fred Rieke lab used a technically challenging technique to record from different layers in the mouse retina, while standard techniques take an average over all retinal layers. They cut vertical slices of the retina instead of placing the flat retinal preparation under the microscope. This way they could study the contributions of different retinal cell layers to adaptation mechanisms, an old passion of Lankheet's. During a sabbatical, he came to the lab to start a project using the same technique to record from primate retina. Some had suggested that the process of retinal adaptation would in fact rely on a number of different mechanisms, but had never been able to directly test this hypothesis. However, with their recording technique Lankheet and colleagues were the first to record from the different retinal cell layers and directly compare adaptation at different sites. Indeed, they demonstrated that the effectiveness of daylight vision relies on at least two retinal mechanisms that adjust sensitivity in the 200 ms interval between saccades. One mechanism takes place in the cone photoreceptors (receptor adaptation) and the other occurs higher up in the retinal circuitry and benefits from convergence of signals from multiple cones (post-receptor adaptation). They found that post-receptor adaptation occurs as signals are relayed from cone bipolar cells to ganglion cells. Furthermore they found that the two adaptive mechanisms are mutually exclusive: as light levels increase the main site of adaptation switches from the higher site to the cones. This was quite an unexpected finding: one would not expect the ganglion cells to know about the adaptation states of the cones.

These findings help explain how human cone vision encodes everyday scenes, and, more generally, how sensory systems handle the challenges posed by a diverse physical environment. One of the Nature reviewers immediately called the paper 'a classic'. Also, this study shows how much can still be learned from low-level vision physiology and how essential these techniques are: they allow us to truly see what happens in the brain.

Dunn, F.A., Lankheet, M.J., Rieke, F. (2007). Light adaptation in cone vision involves switching between receptor and post-receptor sites. Nature, 449, 603-606.



Midget bipolar cell in the primate retina marked with a fluorescent colorant during a perforated patch recording in a slice preparation.

Meeting Helmholtz

Hermann von Helmholtz was a versatile scientist who contributed to a range of academic disciplines. This has been one of the main reasons for naming our multidisciplinary institute after him. But how many of us really know the scientific achievements of this homo universalis? In this series we will

focus on aspects of his work you might not yet be familiar with.

The opening chapter of Helmholtz' Handbuch der physiologischen Optik (1867) deals with the anatomy of the human eye. One critical measure is the radius of curvature of the cornea, which is relevant to the diagnosis of astigmatism. A known approach at the time was to place two lights some distance apart in front of a patient, and to measure, using a kind of telescope and rule, the distance between the two projection images on the surface of the cornea. Helmholtz notes that a major practical difficulty is to keep the patient's eye steady during this procedure: 'in any method in which [...] it is necessary to read the mark on a scale which corresponds to one [...] corneal image and then to read that which coincides with the other [image], even the slightest movement [...] between two readings will add to or subtract from the [distance] as measured.'

So the challenge seems to be to invent a way of reading the distance between the images in a single glance. Helmholtz describes how he solved this, by designing what he calls an ophthalmometer. This is essentially a telescope equipped with two plates of glass in front of the objective, positioned slightly to opposite sides so that the experimenter views only one projection image through each plate. When the plates are both orthogonal to the line of sight the experimenter simply sees a continuous picture of the corneal surface. However, Helmholtz realized that the single picture would be divided into two pictures, shifted relative to eachother, if he rotated the two plates in opposite directions so that they became oblique relative to the line of sight. This is similar to the observed position shift of a fish swimming past the corner of a fish tank, and due to refraction that occurs as light travels from one medium (air) into another (glass). Now, to calculate the distance between the two corneal projection images, Helmholtz only had to find the rotation angle at which the two just touched when viewed through the two glass plates.

The invention worked fine, judging from a table of measurements with the ophthalmometer that Helmholtz provides at the end of the section. Also, the chapter hints at Helmholtz' expertise beyond the study of human senses: He cites the mathematician and astronomer Friedrich Bessel, who used a similar concept to determine the visual distance between Jupiter and its moons.

Interview Ans van Doorn & Jan Koenderink

You can look back on a career most scientists in perception would envy. During your career, you've overseen the early years of the Helmholtz instituut.

Yes, the Helmholtz institute arose from an earlier collaboration between the departments of physics, biology, medicine and computer science, the Utrecht Biophysics Institute (UBI). However, due to lack of funding and changes in the structure of the university, this collaboration was stopped, and we went looking for ways to continue a multidisciplinary approach. Because we'd been working at the psychology department in Groningen, we sought a collaboration with psychology more than, for instance, the computer science members did. So, we were an initial member of the Helmholtz institute when it started.

What benefits do the members of the Helmholtz institute have from being a part of the institute?

The university will change its internal structure quite frequently, and within departments this can cause problems for the survival of singular research groups. However, when these groups are also a part of a KNAW-accredited inter-university institute like the Helmholtz they are also bound to an organisation other than a particular department, and thus they are relatively safe from being disbanded due to departmental reorganisation.

Another benefit is the possibility of doing truly multi disciplinary research by forming teams in which researchers from different disciplines each play their role.

Which of your topics of research do you find most interesting in retrospect?

We had a very nice time during the period when our work, such as that on scale-space, was picked up in the field of computer vision, and these ideas sparked a lot of new research in that field. However, due to the theoretical nature of that work it hasn't been frequently applied in fields of human perception. Also,

our work on local sign and optic flow stands out, and we are still very proud of it. One thing that strikes us is the fact that some of the things we are most proud of haven't received all that much attention, while other things have become succes stories in terms of citations.

Another example of how we were able to bridge multiple disciplines is in pictorial space. Because of our fascination with art we held evening meetings with other art lovers from the university, and these discussions were a lot of fun. Our contacts with art history even led to a few doctoral theses being written. We even inspected paintings by van Eijk with a magnifying glass to find out the exact brush strokes that were used to depict the folding of clothes, or the shape of human bodies. It's here where we could make good use of our physics background because we could calculate a lot in terms of material, folding properties and the like.

The Helmholtz is, besides a research institute, also a 'school' for PhD students. What do you think should be the goal for the diverse students that the Helmholtz teaches?

It is, I think, not a good idea to try to create interdisciplinary scientists, so that physicists become 'amateur psychologists', and we shouldn't try to make amateur physicists out of psychologists. In a multidisciplinary team each has his or her own role, but students from the different disciplines should be taught each other's languages so as to facilitate the communication when they are required to work together. What is most important is that they are able to read each other's papers.

If I were required to create a program, this would surely include linear algebra as well as courses like optics and other areas of physics that have been less 'hip' over time, but undeniably are important in perception research.

Do you have any advice for beginning scientists pursuing a career in perception?

Well, some of our work hadn't been cited for up to 15 years before being rediscovered by others. Joining the mainstream leads at best to "sound but dull" science, more often to mediocrity. Following your own path not only keeps you alert, but often leads to the accidental discovery of surprising views. That is where the real fun of doing research is.

Arnoldus van H.

She is leaving me

These were my last words: ''What did you think, I would do at this moment. If you're standing before me, with tears in your eyes. Trying to tell me, that you have found you another, and you just don't love me no more." Sadly though, I could not convince you to stay. I tried one last - dirty - argument. 'How can you do this to me, I created you!' I even tried crying, in vain.

It all started with some sinewaves, tangents and gaussians. A bit of multiplication, a square root, and there you were. I almost instantly knew you were a woman. I could tell by the your smoothness, the sheer beauty of your curves. I fell in love, quicker than ever before. And boy, do I fall in love easily.

You were a willing partner, my muse. You helped me to get my thresholds, reaction times and aftereffects. What a happy couple we were, we had lots of success, didn't we? O yes, we had our ups and downs. Of course, what loves each other hurts each other, my friend the poet used to say. The time I had you disappear by accident, or when I changed your appearance after too much adaptation. I didn't mean to hurt you then! I'm not sure whether these occasions contributed to the trouble we now have. That you want to leave me, dance for someone else. That you just don't love me no more.

O, I know what you want. You are sick and tired of these things I do: wiggle your thighs while I determine some threshold. You tell me that I'm old-fashioned and that I've lost my appeal. But let me tell you baby, do you really think you will be happier when they put you in that machine, and electrify you with some magnets? What did they tell you, that you could help them find the Great Secret Spot? Baby, the magnets may warm you, but you will never find a place as hot as my everlasting love. Please don't leave me, I can't do without you…

P.S. To anticipate accusations of plagiarism: The first quote is from a song, do you know who wrote it? Send an email to the editors if you do.

News & Agenda

Helmholtz Lectures

- January 11, 2008. Robert Zatorre (McGill University, Canada) Anatomical and functional plasticity in the human auditory cortex: Pitch, speech and crossmodal reorganization.
- February 15, 2008. Alvaro Pascual-Leone (Harvard University, USA) Studying and guiding the changing human brain.
- March 14, 2008. David Leopold (NIH, USA) What is a neural correlate of perceptual suppression?
- April 11, 2008. Eero Simoncelli (New York University, USA) Modeling the visual system.
- May 23, 2008. Steve Palmer (UC Berkeley, USA) Aesthetic science: Understanding preferences for color and spatial composition.
- June 13, 2008. John Maunsell (Harvard University, USA) How attention alters neuronal representations in monkey visual cortex.

PhD defences

- December 20, 2007. Carinne Piekema (F.C. Donders Centre for Cognitive Neuroimaging) Binding in memory.
- January 10, 2008. Jeroen Benjamins (Experimental Psychology, Universiteit Utrecht) Spatiotemporal attentional constraints in perception.
- January 18, 2008. Meike Grol (Experimental Psychology, Universiteit Utrecht; F.C. Donders Centre for Cognitive Neuroimaging) Parietofrontal circuitry in visuomotor control.

New people

- Willemijn Schot. PhD student (Human Movement Sciences, VU University). Project: The grasping of moving objects.
- Floris Klumpers. PhD student (Experimental Psychology, Universiteit Utrecht). Project: The functional neuroanatomy and farmacology of fear inhibition.
- Stijn Massar. PhD student (Experimental Psychology, Universiteit Utrecht). Project: The price of learning good from bad: individual differences, EEG correlates, and pharmacological modulations of fear conditioning and avoidance learning.
- Meike Hartendorp. PhD student (Experimental Psychology, Universiteit Utrecht). Project: Dynamics of the interaction between mental imagery and visual categorization. Funded by the European Science Foundation program "Consciousness in a Natural and Cultural Contest".
- Mirela Kahrimanovic. PhD student (Physics of Man, Universiteit Utrecht). Project: Haptic perception.
- Maartje de Jong. PhD student (Physics of Man, Universiteit Utrecht). Project: Neuroimaging of bi-stable visual perception.

Retirement

- On November 1st Professor Lex Wertheim (Experimental Psychology, Universiteit Utrecht) was given his status emeritus.
- On October 25th Franklin Bretschneider (Functional Neurobiology, Universiteit Utrecht) retired from his function as assistant professor. In honor of his retirement he gave a colloquium titled: "39 jaar bij de UU en nooit een saai moment."

Symposia & Lectures

- January 10, 2008, Retirement lecture of Prof. A.W. Wertheim: 'De theorie als blinddoek'. Auditorium Academiegebouw, Universiteit Utrecht, Domplein 29. Time: 4.15 pm.
- February 1, 2008. Symposium natural scene perception in honor of Jan Koenderink. Universiteit Utrecht. Registration before January 15: Helmholtz@fss.uu.nl.
- From September 21 to 23, 2007 the AMC Amsterdam co-organized the international Amplifon/CRS conference "Bridges of Amsterdam" (www.bridgesofamsterdam.com). Professor Wouter Dreschler was chairman of the scientific program.

Awards

- Sylvia Pont's (Physics of Man, Universiteit Utrecht) plenopter was selected as one of the top five submissions for the NSVV light award. The plenopter measures properties of ambient light that are important to human perception. NSVV stands for Nederlandse Stichting voor Verlichtingskunde.
- Maarten van Beurden (Experimental Audiology, AMC Amsterdam) was awarded the ISAAR poster prize 2007 with his poster "Clinical applications of loudness scaling". ISAAR is the International Symposium on Auditory and Audiological Research (formerly known as "The Danavox Jubilee Foundation").

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