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The Earliest Visualizations of the Living Eye's Fundus by Immersion in Water

Pierwsza przyżyciowa prezentacja dna oka w wodnej immersji

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Summary
On November 12, 1704, the medical doctor Jean Méry presented to the French Royal Academy of Sciences in Paris his observation that if a cat is immersed in water his retinal vessels became visible. On March 20, 1709, Philippe de La Hire pointed out that this was due to the abolition of the corneal refraction.

Méry's experiment of eye immersion was repeated and supplemented later for fundus visualization in humans: in 1845 by Adolf Kussmaul, in 1851 by Johann Nepomuk Czermak for the construction of the "orthoscope", in 1891 by Oswald Gerloff for an successful human fundus photography and in 1910 by Rayner Batten for an "hydrophthalmoscope".

Keywords: history of ophthalmology, ophthalmoscopy, optical neutralization, corneal diopter, Jean Méry, Philippe de La Hire, Adolf Kussmaul, Johann Nepomuk Czermak, Oswald Gerloff

Streszczenie
Dnia 12 listopada 1704 roku doktor Jean Méry zaprezentował Francuskiej Królewskiej Akademii Nauk wyniki swoich badań dowodzących, iż zanurzenie kota pod wodą umożliwia obserwację naczyń jego siatkówki. Niecałe 5 lat później (20 marca 1709 roku) Philippe de La Hire wyjaśnił, że ma to związek ze zniesieniem refrakcji rogówki.

Eksperyment Méry'ego oparty na immersji oka był później powtarzany i wzbogacany przez Adolfa Kussmaula (1845 r.), przez Johanna Nepomuka Czermaka do konstrukcji ortoskopu (1851 r.), przez Oswalda Gerloffa do skutecznej fotografii dna oka człowieka (1891 r.), przez Raynera Battena zaś — wykorzystany w hydro-oftalmoskopii.

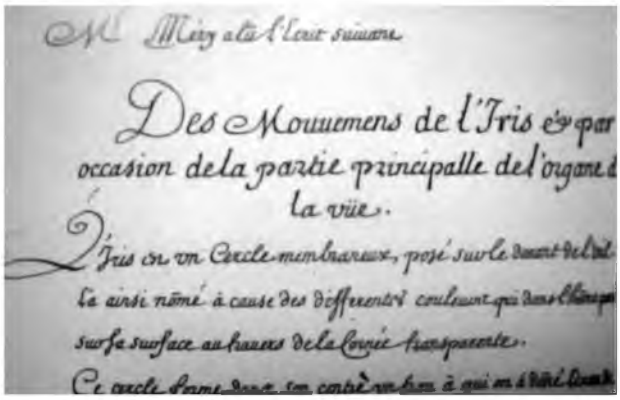
Słowa kluczowe: historia okulistyki, oftalmoskopia, neutralizacja optyczna, refrakcja rogówki, Jean Méry, Philippe de La Hire, Adolf Kussmaul, Johann Nepomuk Czermak, Oswald Gerloff

Introduction

In this 160th anniversary year of the invention of the ophthalmoscope by Herman Helmholtz in 1851, one tends to forget the predecessors who, with less technical and physiological knowledge, could see the retropupillary area of the living eye. The context of this findings can be reconstituted with documents preserved in the archives of the French Academy of Sciences and has been described recently by the author [1, 2].

Méry's presentation

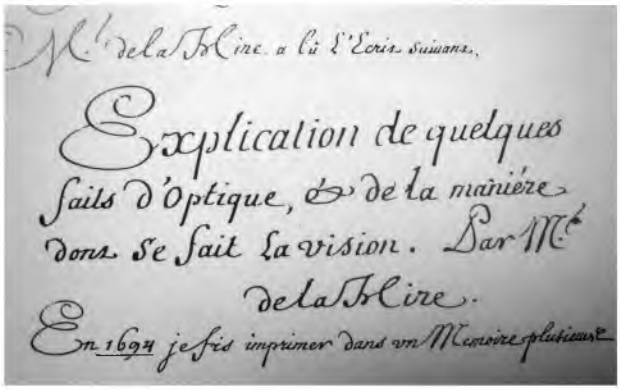
The presentation, on Wednesday November 12, 1704, at the French Royal Academy of Sciences by Jean Méry, surgeon at the Hôtel-Dieu hospital in Paris, of a talk entitled *On the Iris Movements and by Occasion of the Principal Part of the Sight* (*Des Mouvements de l'Iris et par Occasion de la Partie Principale de l'Organe de la Vuë*) would become the subject, over several years, of comments and controversies in the French Academy of Sciences [3, 4].


M. Méry a lû l'Ecrit suivant

Des Mouvemens de l'Iris & par occasion de la partie principalle de l'organe de la vûe.

L'Iris est un Cercle membraneux, posé sur le devant de l'œil, à ainsi nommé à cause des differentes couleurs qui dans l'homme se font voir sur sa surface au travers de la Cornée transparente.

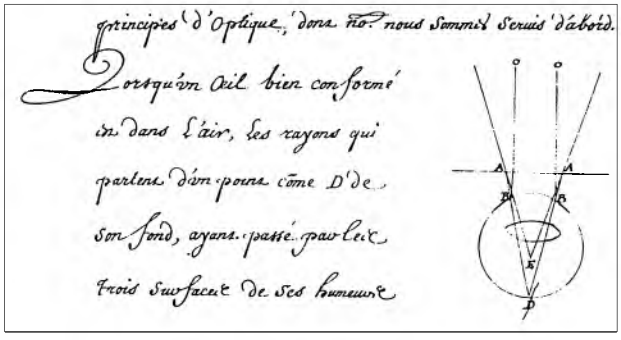
FIG. 1. Extract from the Proceedings of the Royal Academy of Sciences for the year 1704, vol. 23, p. 277 verso — Session of Wednesday 12th November 1704. Minute of Jean Méry's lecture *On the Movements of the Iris and on Occasion of the Principal Part of the Organ of the Sight*


M. de la Hire a lû l'Ecrit suivant.

Explication de quelques faits d'optique, & de la maniére dont se fait la vision. Par Mr de la Hire.

En 1694 je fis imprimer dans un Memoire plusieurs

FIG. 2. Extract from the Proceedings of the Royal Academy of Sciences for the year 1709, p. 103 recto — Session of Wednesday 20th March 1709. Minute au Philippe de La Hire's lecture *Explanation of Several Optical Facts and of the Manner in which Vision Occurs*


principes d'Optique, dont nous nous servirons d'abord.

Lorsqu'un Oeil bien conformé

est dans l'air, les rayons qui

partent d'un point comme D de

son fond, ayant passé par les

trois Surfaces de ses humeurs

FIG. 3. Extract from the Proceedings of the Royal Academy of Sciences for the year 1709 — Session of 20th March 1709. By this diagram, La Hire explains the visualisation of the fundus of the submerged cat by the fact that the surface of the water having abolished the corneal dioptric power, the rays coming out of the eye would no longer be parallel, but would diverge and that would make the eye fundus visible to the observer

While plunging the head of a cat in water, Jean Méry made a new and unpublished observation. It caused a non-reducible pupillary mydriasis in spite of intense lighting and made visible the retinal vessels, the optic nerve head, and the choroid. Méry deduced, in accordance with the theories of his time:

Firstly, that the iris was relieved of congestion when breathing stopped. The iris would be comparable with the cavernous body of the penis, which became flaccid in the same circumstances, when the "animal spirits" do not reach that point any more.

Second, that the visualization of the bottom of the eye had been made possible by three factors: the areflectic mydriasis, the intense lighting, and the flattening of presumed innumerable and microscopic irregularities and folds of the corneal surface.

The report register of the Academy does not give indications on possible discussions or controversies after this talk.

The Méry-La Hire controversy

It is nearly five years later, Friday March 20, 1709, that the French physicist Philippe de La Hire gave at the Academy of Sciences a presentation, which calls into question the fallacious conclusions that Méry had drawn from his observation. The title of the talk is "Explanation of some Facts of Optics and the Way in which the Vision make" (Explication de Quelques Faits d'Optique et de la Manière dont se fait la Vision) [5, 6]. It is necessary to point out that De La Hire had published 15 years before, in 1694, a "Treatise of the Different Accidents of the Sight" from which he still drew certain fame [7]. Though his celebrity, who got him the intimacy of the King, came of his works of geometry and astronomy.

In his talk at the French Academy of Sciences, De La Hire interprets the observations on the immersed cat's eye by the "laws of optics", without it being necessary to call upon the animal spirits. The mydriasis would be secondary to the defocusing of the light rays at the time of its crossing the water. While arriving dispersed on the retina, the light would not produce there enough effect to constrict the pupil. (Of course this explanation of the mydriasis is wrong). The vision of the eye's bottom is due to the abolition of the catadioptric effect of the luminous reflection on the convex surface of the cornea and to the replacement of the dioptric curvature of the cornea by the plane surface of the liquid.

This controversy nourished thereafter debates at the French Academy. During the following months and years, the report-register records more than ten lectures and communications by Méry. His last communication, Saturday August 27, 1712, was followed by a debate. The

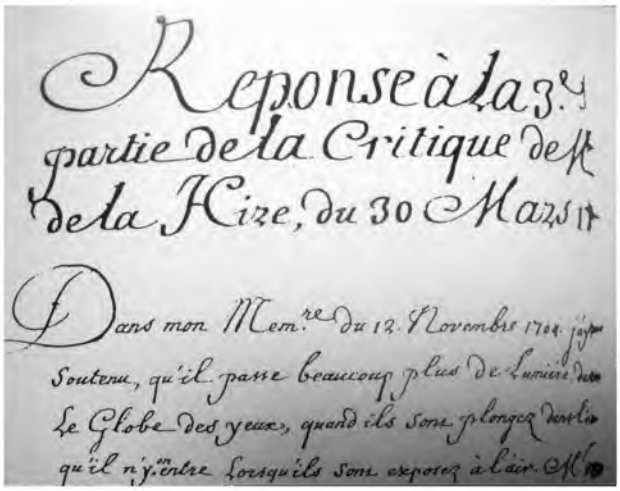

Réponse à la 3.e
partie de la Critique de M.r
de la Hire, du 30 Mars 17
Dans mon Mem.re du 12. Novembre 1704. j'ay
Soutenu, qu'il passe beaucoup plus de Lumiere dans
le Globe des yeux, quand ils sont plongez dans l'eau
qu'il n'y entre Lorsqu'ils sont exposez à l'air. M.r

FIG. 4. Extract from the Proceedings of the Royal Academy of Sciences for the year 1712, vol. 31, p. 317 — Session of Saturday 27th August 1712. On July and August 1712, Méry read a *Reply to the Third Part of the Criticism of Mr. de La Hire*

report register of the Academy gives of it a softened report, of which we retain the following sentences: "The true cause (...) why one see the retina of the cat's eye (...) is that, in the water, the cornea (...) has not the effect of a convex mirror and that its convex surface is replaced by the homogenous plane water surface" [8, 9, 10, 11].

Discussion

From these debates and controversies among the French academicians, three centuries ago, one can conclude that Méry is credited with having carried out and described in 1704 the earliest neutralization of corneal curvature in a living animal with the contact of a liquid and the earliest eye fundus visualization of a living eye. La Hire has the credit of having reproduced Méry's experiment, and to give in 1709 the optical and physiological explanation of the neutralization of the corneal curvature and its replacement by the water surface. The French Royal Academy of Sciences has the credit of having documented in 1712 the conclusions of La Hire and to have affirmed solemnly that the visualization of the eye fundus requires a mydriasis, an intense coaxial lighting, the abolition of the corneal reflection, the optical neutralization of the corneal curvature, and the replacement of this curved surface by the plane surface of water.

Biographies

Jean Méry (fig. 5) was born 1654 in Vatan, in the South of Paris, where his father was a surgeon. He took his training in surgery at the Hôtel-Dieu hospital of Paris, where he was characterized by his assiduousness and his intelligence. His career was brilliant. He had the follow-

FIG. 5. Jean Méry (1645–1722)

FIG. 6. Philippe de La Hire (1640–1718)

ing titles and functions: first surgeon of the Hôtel-Dieu hospital, member of French Royal Academy of Sciences, surgeon to the Queen, surgeon to the Invalids, etc. At the time of his death, 1722, at the age of 77 years, he left many works of anatomy and surgery.

Philippe De La Hire (fig. 6) was born 1640 in Paris, where his father was a well-know artist. He studied mathematics and geometry and was in charge of cartography of the French Kingdom. In addition to his treaty on the sight (1694) and his talk on optics of the immerged cat, La Hire published many work on astronomy, geodesy, physics and mathematics. He died in 1718, at the age of 78 years [12].

Mery's successors

Méry's experiment, interpreted by De La Hire, remained unknown for nearly one and half centuries. Then in 1845, Adolf Kussmaul, student in Heidelberg and future professor in Strasbourg, confirmed these experiments of visualization of the eye's fundus by water immersion of living and fresh eyes. But he failed when he tried to replace the liquid by a plano-convex glass lens, made so that its concavity matched the convexity of the cornea [13].

After the invention of the ophthalmoscope by Hermann Helmholtz in 1851, the physicians and physiologists of Prague remembered Méry's experiment [14]. In 1852, Adolf Ernst Coccius repeated Méry's eye immersion and recommended the examination of the eye's fundus through a water drop maintained on the cornea by a microscope glass plate, or through a modified eye-cup, where the bottom is cut out and is replaced by a plane glass plate [15, 16]. The following years, Johann Nepomuk Czermak used a water-box which he had just invented, named "orthoscope", to neutralize the corneal curvature and thus to observe the retina [17, 18]. His description refers explicitly to Méry and La Hire. The following years, the Czermak's orthoscope was improved and adapted by Hasner for the clinical use [19]. Helmholtz, who was unaware of Méry's and La Hire's priorities, did note them only later in the first edition of his treatise of physiological optics in 1864 [20].

After the discovery of local anesthesia, by Carl Koller in 1884, it was much easier to touch the eye [21]. In 1891, August Eugen Fick of Zurich placed a tube filled with water on the cornea of a rabbit for the photography of his fundus [22]. The same year 1891, Oswald Gerloff made a successful ophthalmoscopic photography through a water-orthoscope. He used a magnesium flash, which was not without risk for the patient and for the physician [23]. In 1910, Rayner Batten described a metal eyecup with a plane glass fitted into it, the "hydrophthalmoscope", which filled with water and applied to the eye assists him for the inspection of the fundus without ophthalmoscope [24].

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