

3<sup>rd</sup> Global

# Pediatric Ophthalmology Congress

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## Theory- Actuating mechanisms of accommodation and development of the theory of accommodation by Helmholtz

### 1. Development Helmholtz theory of accommodation.

Basic Helmholtz of lens accommodation theory (HLAT) has stood the test of time [1]. However, the truth of accommodation was disclosed only in part, and on the basis of HLAT could not be attributed to a number of physiological and clinical facts. In particular, HLAT cannot explain facts partial ability to accommodation in the eyes with the artyphacia and aphacia. In addition, actuators in HLAT were not fully developed. Traditional views on the functioning of the single lens mechanism of accommodation on HLAT violate the laws of mechanics. It is believed that when you look "completely near" zonula fiber relaxed, but then in the eye do not have structures that hold the lens in position (fig. 1).

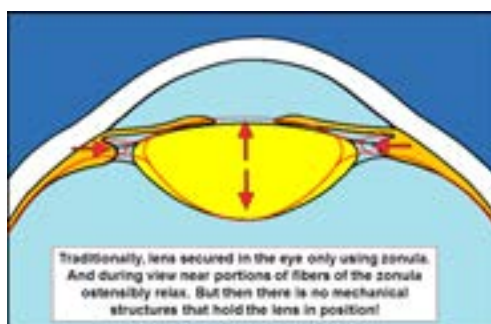


Fig. 1. Traditional views on the lens in the eye do not conform to the laws of mechanics [2,7,8].

However, Helmholtz considered that when looking "totally near" the Zonula fiber did not relax but only weaken [8]. I.e. in all phases of accommodation the Zonula fiber is tight, and when vision nears the minimum, while vision distance maximum [9]. Our research has made it possible to develop basic HLAT, which for now is consistent with the laws of mechanics in all phases of accommodation [7-11]. Also we have been able to find many other additional mechanisms of accommodation [12].

Table 1 [1,2-5,12,14].

Actuators lens accommodation	
By H. Helmholtz (1855), J. Rohen (1969), R. Schachar (1999,2000), etc.	By O. Svetlova, I. Koshits, K. Kotlyar (1998,1999)
<b>The only adjustment mechanism:</b>	<b>The basic mechanism of accommodation:</b>
<ul style="list-style-type: none"> <li>✓ Active ciliary muscle</li> <li>✓ Zonula fibers</li> <li>✓ Capsule of lens</li> </ul>	<ul style="list-style-type: none"> <li>✓ Active ciliary muscle</li> <li>✓ Zonula fibers</li> <li>✓ Capsule of lens</li> <li>✓ Choroid</li> <li>✓ Vitreous Chamber</li> </ul>
<p><b>Do not participate:</b></p> <ul style="list-style-type: none"> <li>➢ Choroid</li> <li>➢ Vitreous Chamber</li> </ul>	<p>Also involved additional mechanisms of accommodation</p>

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Table 1 provides a list of executive mechanisms of lens accommodation on Helmholtz, etc. before and after our research. Note that the natural crystalline lens and cornea astigmatism changes at different phases of adjustment. Levelling these changes is possible only in case of uneven accommodation, when muscles ciliary tone in different it segments differ from each other.

## 2. The basic and additional mechanisms of accommodation.

The tension of the zonula depends on the size of stretching "biological spring" - choroid. Muscle ciliary (MC) stretches or weakens the elastic structure of choroid. It should be noted that MC is behind in choroid in the area dentate line and corneal stroma in front [8]. Front and rear portions of the zonula fiber fastened between the lens capsule and choroid in the field of jagged lines, and are not directly related to muscle ciliary [8,10,12]. Such structure of zonula fiber allows you to press the lens to the Vitreous Chamber in all phases of accommodation. Vitreous Chamber and zonule fiber provide hold lens on the center of the optical axis. In addition, the Vitreous Chamber is constantly damps vibrations of the lens. Our scheme HLAT is shown in Figure 2 [8].

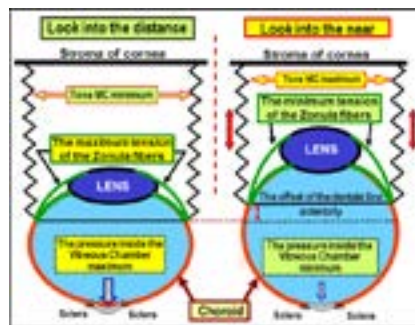


Fig. 2. The mechanism of lens accommodation in humans that adequate laws mechanic [7].

In nature are known for different ways of guidance optical system to sharpen. The main ways of achieving sharp images are presented in Fig. 3, and all of them are implemented in the human eye.



Fig. 3. Optical Methods to sharpen command that are present in the human eye.

The evolution of mechanisms of accommodation in birds, reptiles and many animals has led to the creation of the human eye with generalized mechanism accommodation (fig. 4). This generalized Executive accommodation mechanism in humans consists of intraocular and extraocular links. Extraocular mechanisms can be clearly divided into scleral and corneal, as well as corneal-scleral (for example, the Eyelid compression mechanism). Intraocular mechanisms consist of the lens accommodation - the primary Helmholtz mechanism and many other additional mechanisms of accommodation.

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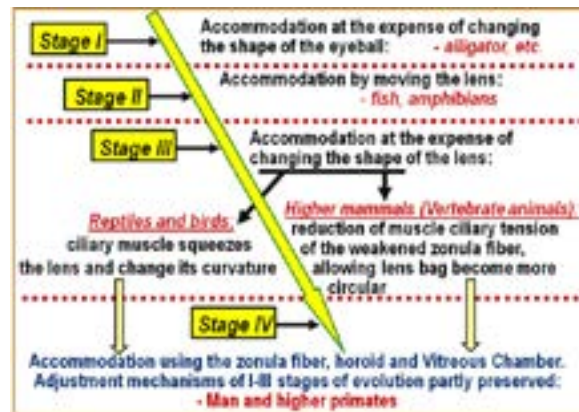


Fig. 4. Phases of the evolution of executive mechanisms of accommodation by S.I. Shapovalov, I.N. Koshits [8].

Only our classification today is present the basic mechanism of Helmholtz lens accommodation and 13 additional executive mechanisms of accommodation. Note that we found also detected a new executive mechanism of accommodation, which is present in the lens. A mechanism for changing the refractive power of the lens by using the front and rear mini-lenses. These mini-lenses are part of lens capsule and allow you to focus the beams going around the optical axis of the eye, even with a narrow pupil (Fig. 5) [13].

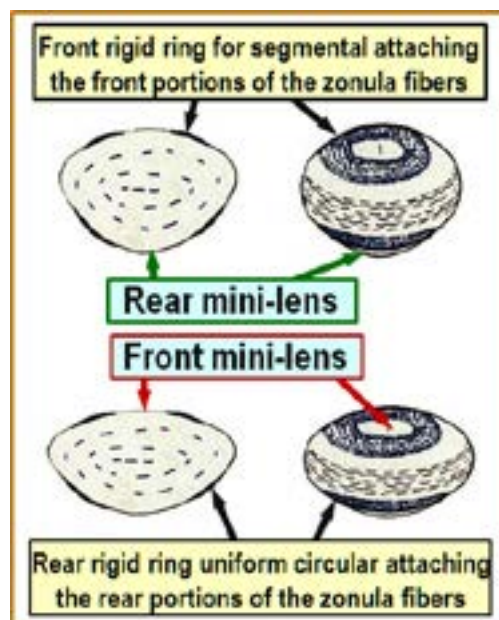


Fig. 5. Mini-lens lenses that provide extra tip optics eye sharpness even when you narrow the pupil.

Change the radius of the rounding and mini lens refractive power is associated with a change in pressure inside the lens at different phases of accommodation. For example, when pressure inside the lens near vision as much as possible, and with vision away - minimal [8]. Therefore, both mini-lens have a maximum capacity for focusing the work of near. Diagram of the mini-lens attend as an additional executive machinery accommodation provided in Figure 6 [13].

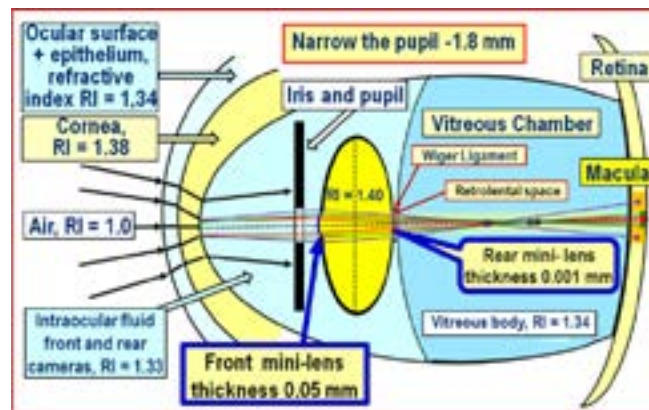


Fig. 6. Scheme eye on sharpness using mini-lens when working near and in bright light [13].

On the diagram, notice that the cornea itself is weakly dispersive lens. It is worth noting that this new mini-lens accommodation mechanism could change our ideas about the theory of accommodation as a whole, but it can also serve as a natural analogue for the development of accommodative intraocular lens for the new generation.

Conclusion. The our common classification [8,10] there are intraocular and extraocular actuating mechanisms of accommodation. They allow you to explain the volume of accommodation in 2.5 diopters even in the eye with artiphacia. Extraocular additional mechanisms of accommodation are as follows. Corneal: Mechanism of narrowing eye lids for increasing depth sharpness and mechanism of the changes radius and astigmatism of the cornea when the ciliary muscle tone at the maximum. Scleral mechanism: changing the length of the optical axis of the eye sclera is compacted outer muscles. Cornea-scleral mechanism: the combined change in corneal astigmatism and the length of the optical axis of the eye convergence-divergence. Extra capsulated mechanisms: mechanism of narrowing of the pupil, the mechanism of curvature of the surfaces of the lens capsule, mechanism of displacement along the optical axis of lens capsule, change mechanism of astigmatism lens - uneven accommodation in different meridians, change mechanism of elasticity horoidei structures, fixed installation mechanism of the retina, local retinal displacement mechanism. Intra capsular mechanisms: possible change in the mechanism of the optical power of the lens nucleus, mechanism of refractive power change mini-lens lenses. All these mechanisms operate in relationship with one other. The fastest accommodative mechanisms is the narrowing eye lids with the help of striated muscles, as well as the work of the extraocular eye muscles striated. Ciliary muscle is a slow reflex muscle, therefore, all accommodative mechanisms that are associated with it, cannot be attributed to fast.

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## Biography

Olga Svetlova, Med.Sc.D., professor of Department Ophthalmology of North-Western State Medical University named after I.I. Mechnikov. Author of 211 scientific works, 2 monographs (2016). More than 25 years, conducts research on Biomechanics and physiology of the eye at the intersection of academic disciplines. The co-author generalized classification of executive mechanisms of accommodation and proposals for development of the theory of accommodation of lens by Helmholtz, including the joint work of the front mini-lens and posterior mini-lens in the capsule of the lens to create a sharp image. Co-author and developer of the theory of functions of fibrous sheath eyes, the theory of open angle glaucoma and metabolic adaptation theory of acquired myopia. As well as the co-author of new dynamic diagnostic methods to determine the in vivo new physiological and biomechanical characteristics of the eye

Ivan N. Koshits, mechanical engineer, a member of the St. Petersburg Sechenov Society of physiologists, biochemists, pharmacologists. Author of 59 scientific works in biomechanics, normal and pathological physiology of the eye and its elements, 2 monographs (2016). Organizer and co-head of the first scientific conferences in Russia on the Biomechanics of the eye in 1998-2011. Co-author and developer of the theory of functions of fibrous sheath eyes, the theory of open angle glaucoma and metabolic adaptation theory of acquired myopia. As well as the co-author of dynamic diagnostic methods to determine the in vivo new physiological and biomechanical characteristics of the eye. General Director of Petercom-Network / Management Systems Consulting Grope Cl. Corp

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