



SPEED OF ACCOMMODATIVE RESPONSE IN RELATION TO AGE AND REFRACTIVE STATUS

BRZINA AKOMODATIVNOG ODGOVORA U ODNOSU NA DOB I REFRAKTIVNI STATUS

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ABSTRACT

The simplest explanation of accommodation is the ability of eye to focus on objects which are close the same way as in the distance. The speed at which the eye attains this is one more aspect of human sight. Importance of speed of accommodation, the way of investigation, differences in rapidity of accommodation speed to age and differences in speed of accommodation related to condition of refraction are pointed out in this work. We also strive to introduce the results of a certain research and give our opinion about it. The analysis shows that younger individuals have faster accommodation than older ones, and that myopes have slower accommodation speed compared to emmetropes and hyperopes.

Key words: accommodation speed, accommodation, refraction faults,

SAŽETAK

Akomodacija je, najjednostavnije rečeno, sposobnost oka da fokusira predmete koji su blizu jednako dobro kao što to čini na daljinu. Brzina kojom to oko postiže predstavlja još jedan važan aspekt ljudskog vida. U radu je istaknuta važnost brzine akomodacije, način ispitivanja iste, razlike u brzini akomodacije s obzirom na godine te razlike u brzini akomodacije u odnosu na refrakcijska stanja. Također, u radu smo nastojali predstaviti rezultate određenih istraživanja i dati svoj osvrt na iste. Analiza je pokazala da mlađe osobe imaju bržu akomodaciju od starijih, te da miopi imaju lošiju brzinu akomodacije u usporedbi s emetropima.

Ključne riječi: brzina akomodacije, akomodacija, refrakcijske greške

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INTRODUCTION

A healthy eye can clearly focus on objects both at a distance and up close. When a person looks at a distant object, the image is clear and sharp, and when looking at a nearer object, the eye automatically adjusts so that this object is also seen clearly (Tulumović and Teskeredžić, 2019). This process is called accommodation. Accommodation is the process of the eye adjustment in which the refractive power of the lens changes depending on the distance of the observed object. It is the ability of the eye to clearly see objects located at different distances between the nearest and farthest points of clear vision (Zeljko, 2013). According to the authors Vargas et al. (2019), accommodation is a reflex increase in the dioptric power of the lens that enables focusing from distant to near objects. The far point (*lat. Punctum remotum*) is the farthest point that a person can see clearly without accommodation (Guyton and Hall, 2012; as cited in Gaćeša, 2023), while the near point (*lat. Punctum proximum*) represents the closest distance at which the eye can clearly see the observed object (Temunović, 2011). We can always determine the nearest point of clear vision, while the farthest point of clear vision is generally an abstract concept, except in cases of myopia where it can be clearly defined. In an emmetropic eye, parallel rays coming from infinity intersect at one point on the retina, which is why its farthest point of vision (Punctum remotum) is considered to be at infinity. In practice, a distance greater than 6m is taken as such (Denić, 2011). Accommodation is a reflex action regulated by the autonomic nervous system, but it can also be voluntary (Tulumović, 2018). The process of accommodation is enabled by the accommodative apparatus of the eye, which consists of: the ciliary body, the ciliary muscle, the choroid, the zonular fibers, the lens capsule, and the lens. The ciliary muscle is responsible for controlling this mechanism (Romić, 2020). The ciliary muscle is the key smooth muscle that, through its contractions, changes the refractive power of the eye lens, enabling near accommodation (Purves et al., 2001; as cited in Kovač, 2024). In an emmetropic eye, parallel light rays arriving from infinity, after refraction through the optical system of the eye, are focused precisely on the retina (Marković, 2015). Objects located at a distance of less than 6 meters emit divergent rays that, after refraction, fall behind the retina (Teskeredžić and Tulumović, 2013). In the area of the macula, or the yellow spot, a blurred image is formed, which triggers the accommodation reflex, that is, the contraction of the ciliary muscle. With the contraction of the ciliary muscle, that is, its circular fibers, the ring that forms the ciliary body around the equator of the lens narrows, causing relaxation of the zonular fibers and an increase in the curvature of the lens (Biga et al., 2009). In the phase of disaccommodation, the anterior surface of the lens has a lower curvature in comparison to the posterior surface. At maximum accommodation, the curvature of the anterior surface of the lens increases significantly, while the posterior surface changes only slightly. In this way, the lens becomes thicker (about 0.4 mm) and, since it rests on the vitreous body, it moves slightly forward, pressing the pupillary part of the iris and causing the anterior chamber of the eye to become slightly shallower in that area (Karaahmetović, 2012). These changes in the shape of the lens lead to a significant increase in its refractive power. In children at 8 years of age, the increase in refraction amounts to as much as 13–14 D. In this way, the lens increases its refractive power from +20 D (state of disaccommodation – distance vision) to +33 D at maximum accommodation when the observed object is 7–8 cm in front of the eye (Denić, 2011).

The aim of this paper is to present the importance of the speed of ocular accommodation in everyday visual functioning, to analyze the methods used to assess it, and to consider differences in the speed of accommodation in relation to age and the presence of refractive errors. Through a review of relevant literature, the study aims to determine how factors such as age and type of refraction influence the speed of the accommodative response, and to consider the possibilities of improving this function through visual training.

AMPLITUDE AND RANGE OF ACCOMMODATION

Humans have a highly developed accommodative ability of the eye and possess good visual acuity for near and distance vision (Čupak, 1990; as cited in Vratarić, 2020). The accommodative ability of the eye is characterized by the amplitude and range of accommodation (Stanojević, 2012).

The amplitude of accommodation is the number of diopters by which the lens is capable of changing its refractive power from a state of full disaccommodation to maximal accommodation (Glavaš, 2018). The total accommodative ability can amount to 14 diopters at the age of 8, and it gradually decreases throughout life until around the age of 55 (Jurinić, 2017).

The amplitude of accommodation decreases with age because of increased rigidity of the lens, which prevents sufficient curvature of the anterior surface of the lens (Bušić et al., 2014; as cited in Romić, 2020), and therefore the distance from which a person can see clearly increases (Parkinson, Linthorne, & Matchett, 2001). For example, in individuals over 60 years of age, accommodation decreases below 1 diopter, which means they are unable to focus at distances shorter than one meter (Parkinson et al., 2001). This process is physiological and occurs as a consequence of aging, and it is defined as presbyopia (Bušić et al., 2014; as cited in Romić, 2020). In school-aged children, that distance is about 9 cm (± 2 cm) (Parkinson et al., 2001). Objective measurement of accommodation has shown that the accommodative power decreases by 2 to 3 diopters per decade of life (Cerovski et al., 2015; as cited in Kovač, 2024).

The amplitude of accommodation can be measured by objective and subjective methods (Kovač, 2024). Objective methods are used to obtain results with high accuracy during an eye examination, using instruments such as aberrometers and autorefractors (Win-Hall & Glasser, 2008). Among subjective methods for assessing the amplitude of accommodation, the Push-up method is most commonly used. This is a method of determining the near point of accommodation by moving a test object (made of small symbols) that subtend an angle of one minute (this corresponds to the 6/6 or 20/20 line) (Stanojević, 2012). This method involves moving a visual target towards the subject's eye (using a ruler) until the subject signals that blurring has occurred (Paulik, 2018). It is performed by slowly bringing the target along the ruler toward the subject, with the eyes slightly lowered, until it becomes blurred. If the subject can return the target back into focus, it is again moved toward the subject until they can no longer regain clear focus. The obtained distance is recorded in centimeters. The target is then moved backward until the subject can see it clearly, and this distance is also recorded ("pull-back" value). The amplitude of accommodation is the average of the "push-up" and "pull-

back” values. The target should be the smallest print that can be clearly seen when it is at the far end of the ruler (Stanojević, 2012).

The distance between the far and near points of clear vision is called the range of accommodation. This means that the optical system of the eye is capable of forming a clear image of all objects that lie within the range of accommodation, that is, in the space between the far and near points of clear vision (Pikula, 2020). The range of accommodation is measured in meters, from the far point of clear vision (punctum remotum), which is at infinity in an emmetrop, to the near point of clear vision (punctum proximum), which is at a distance of 7–8 cm in front of the eye in an eight-year-old emmetropic child (Glavaš, 2018).

ACCOMMODATION SPEED

It is considered that an accurate description of the speed of the accommodative act was not obtained until the work of Kirchoff (1941; as cited in Allen, 1956), who photographed changes in the curvature of the eye lens during increases and decreases in accommodation. The speed of the accommodation reflex is 0.5 to 1.5 seconds (Noorden, 1999; as cited in Tulumović, 2018), and relaxation, that is, disaccommodation, ranges from 0.8 to 1.3 seconds (Tulumović & Teskeredžić, 2019). Disaccommodation refers to the return from the accommodated state to the resting state (Tulumović & Teskeredžić, 2019).

Authors Campbell and Westheimer (1960) aimed to measure precisely how quickly and accurately the eye reacts to changes in the distance of an observed object. The study included six young, emmetropic individuals (20–40 years), with monocular stimulation (one eye only), and with dilated pupils. The authors examined the reaction time of the eye to a focus change, the speed of accommodation (how quickly the eye can change focus), the total duration of the eye’s response, and the response to sinusoidal (rhythmic) changes in distance.

Howland, Dobson, and Sayles (1987) examined how and how quickly infants (babies aged 2 to 10 months) can adjust the focus of the eye (accommodation) when they are shown visual targets at different distances. They also examined whether babies with astigmatism appropriately adjust focus when viewing images of different orientations (horizontal and vertical stripes). Twenty-nine infants aged 2 to 10 months participated, divided by age groups. They were shown various targets such as square grids and horizontal and vertical lines that were static at distances of 25, 33, 50, and 100 cm, as well as circular lines that rotated slowly (one revolution every 14 seconds). The speed and accuracy with which infants adjusted focus when the target distance changed were measured. Two video cameras with optical attachments capable of measuring eye focus from a distance (1.5 m) were used.

It is considered that the accuracy of accommodation is more important than its speed when accommodating to a specific near object that captures our attention (Schor & Bharadwaj, 2005). The speed of accommodation is tested subjectively in clinical settings by having patients perform the Flipper test, which involves alternately placing plus and minus lenses (usually ± 1.5 or ± 2.0 diopters) in front of one or both eyes while the patient views a distant (for example, 6 m) or near (for example, 40 cm) object. The subject indicates when the visual target is in focus by saying “clear,” after which the examiner switches to the other lens. A recommended method is for the subject to read a word from sentences to ensure that the target is sufficiently focused. The task is continued for a predetermined number of Flipper cycles or

for a fixed time period. Individuals with normal accommodation speed can perform 12–20 complete cycles in 60 seconds, depending on whether the test is performed monocularly or binocularly, on the power of the lenses used, the target distance, the way the subject signals focus, the manner in which the lens is changed, and whether the subject is hypermetropic or myopic (Radhakrishnan et al., 2007; as cited in Maxwell et al., 2012).

Individuals with accommodative inflexibility, that is, those who have a low Flipper test rate, often undergo visual exercises in which they train accommodation with flippers on near and far targets, perform “pencil push-ups” by focusing on a printed pencil while smoothly changing distances. Individuals are usually required to practice these skills in a clinic under supervision and at home over a period of 4–6 weeks or longer (Maxwell et al., 2012).

Authors Maxwell, Tong, and Schor (2012) addressed the question of whether the speed of accommodation, that is, the ability to quickly and accurately focus on objects at different distances, can be improved through targeted visual training. Although numerous previous studies have shown that accommodative ability can be subjectively improved through exercises such as Flipper tests or pencil focusing, few have objectively measured these changes, particularly with regard to the speed and accuracy of responses. Twelve participants, mostly students, took part in the study. The participants underwent two different training protocols. In the first, they were shown simple visual stimuli that abruptly changed focus from zero to 2.5 diopters and back, while the second involved double changes—first from zero to 2 diopters, and then, 350 milliseconds later, to 4 diopters. The goal of these training protocols was to simulate real changes in viewing distance to which the eye must respond, thereby training its ability to adapt.

The speed of accommodation plays an important role in monitoring aging of the eye. The speed of accommodation, that is, the ability of the eye to quickly adapt to changes in viewing distance, changes significantly with age. As a person ages, there is a progressive decline in that speed, primarily due to the loss of elasticity of the eye lens and decreased contractility of the ciliary muscle.

Schaeffel, Wilhelm, and Zrenner (1993) investigated how eye accommodation changes in relation to age and refractive errors such as myopia and hyperopia. The study included 39 participants aged 5 to 49 years with different refractive statuses, ranging from -4.5 to $+2$ diopters. Under binocular viewing conditions, participants first observed a monitor placed at a distance of 1.3 meters, then read text at different near distances, and finally refocused on the monitor. In this way, changes during shifting gaze from a near to a distant target and vice versa were examined.

ACCOMMODATION SPEED IN INDIVIDUALS WITH REFRACTIVE ERRORS

Refractive anomalies refer to errors in the refraction of parallel light rays entering the eye (Kalauz, Lukenda, Kordić, & Kuzman, 2010). Refractive errors (lat. ametropia) arise from a mismatch between the length of the eyeball and the refractive power of the optical system, leading to blurred images and reduced uncorrected visual acuity (Tomljenović, 2018). There are three basic groups of ametropias. These are myopia (lat. myopia), hypermetropia (lat. hypermetropia), and astigmatism (lat. astigmatismus). Myopia is a condition of the eye in which the image of the observed object is formed in front of the retina (Jurinić, 2017).

As the name itself suggests, individuals have clear vision when viewing near objects, while viewing distant objects results in blurred vision (Bodakoš, 2024). Hypermetropia (lat. hypermetropia) is a condition of the eye in which the rays entering the eye intersect at a point behind the retina (Tomljanović, 2022). A hypermetropic person sees blurred objects that are located in close proximity, while clearly seeing objects that are far away (Lang, 2000; as cited in Halauš, 2017). Astigmatism (lat. astigmatismus) is a refractive error of the eye also referred to as cylinder. It occurs due to an irregularly curved cornea, which does not refract light rays equally in all meridians, and sometimes due to an irregularly curved lens (Ivanišić, 2015). An astigmatic eye sees the image of the observed object distorted, elongated, and unclear, at both distance and near (Ivanišević et al., 2015; as cited in Vukić, 2018). Emmetropia (lat. emetropia) is a state of the eye in which, with relaxed accommodation, parallel light rays are precisely focused on the retina (Pallikaris, 2020).

A hypermetropic person, under equal conditions, must accommodate more than an emmetropic person, which is logical because hypermetropia is reflected either in a too short eyeball or insufficient optical power of the eye that must be compensated by accommodation (Pikula, 2020), while a myopic person accommodates significantly less than an emmetropic person (Culhane & Winn, 1999).

In a study conducted by Ghoushchi, Prieto, and Artal (2019), the authors examined whether there is a difference in accommodation speed between individuals with normal visual acuity and those with different degrees of myopia. Their aim was to better understand how refractive errors, especially myopia, may affect the eye's ability to quickly change focus from distance to near and vice versa. The study included eleven young adults, aged between 21 and 34 years. All participants had refractive errors ranging from zero to -5.5 diopters, with very mild astigmatism. During the study, each participant was shown visual targets at two different distances: one at 2.8 meters (distant target) and the other at only 35 centimeters (near target). Participants underwent a series of tests in which they had to repeatedly shift focus from one visual target to the other, while the researchers monitored how quickly and accurately the eye adapted to these changes.

Authors Ghoushchi, Mompeán, Prieto, and Artal (2021) studied the dynamics of three important visual functions: accommodation (focusing of the eye), convergence of the eyes, and pupil size changes, in individuals with different degrees of myopia. They focused on determining how these functions operate together and whether the degree of myopia affects their speed and coordination. The study was conducted on eighteen young individuals, with an average age of 25 years, whose refractive error ranged from zero to -7.5 diopters. The participants did not have any other eye diseases or functional impairments that could influence the results. All had good corrected visual acuity. During the test, the participants alternated between viewing near and distant targets, while all data were recorded 25 times per second.

METHOD

To identify studies, the following databases were searched: ResearchGate, PubMed, Google Scholar. The studies found were published between 1960 and 2021, and the following keywords were used: accommodation speed, accommodation, refractive errors, age. In the next step, available complete scientific papers were selected that included research on accommodation speed in emmetropic individuals, studies addressing accommodation speed in individuals with refractive errors, and accommodation speed in relation to age.

PREVIOUS SCIENTIFIC FINDINGS ON ACCOMMODATION SPEED

Campbell and Westheimer (1960) conducted a study involving six young, emmetropic individuals (20–40 years). They found that the time that elapses between the moment a stimulus appears and the moment the eye begins to react has an average value of 0.37 seconds. In other words, 0.37 s after an object moves, the eye begins to adjust its focus. The time that passes from the onset of stimulus to the achievement of a stable level of accommodation near the required focus is about 1 second for monophasic responses. When the response has multiple phases, the total time may reach 2 seconds or more. In addition, the authors examined the speed of accommodation and obtained results showing that the maximum accommodation speed achieved during a shift of 2 diopters is approximately 10 diopters per second. When the response occurs in a single sweep, the duration of accommodation does not depend on the magnitude of the change. The authors provided average values for accommodation time: 0.64 seconds for far-to-near accommodation and 0.56 seconds for near-to-far accommodation. When the image moves toward the eye and back (like an accordion), the eye attempts to follow these changes. However, if the changes occur too quickly, the eye can no longer follow them. The authors reported that the eye can follow frequency changes up to about 4 cycles per second (4 Hz)—beyond this point it loses rhythm. In the study by Howland, Dobson and Sayles (1987), which investigated accommodation in infants aged 2 to 10 months, it was found that all infants accommodated successfully and in the correct direction—meaning that their eyes automatically adjusted focus in accordance with changes in the distance of the target they were observing. This finding indicates that even at a very early age the visual system functions precisely enough to detect distance changes and respond with appropriate focusing. The speed of accommodation was exceptionally high, with recorded values reaching as much as 4.6 diopters per second, comparable to the accommodation speed in adults. Of the 21 recorded instances of distance change, only one case demonstrated a delayed response, while all others reacted within 0.5 seconds, further confirming the efficiency of their accommodative system. In infants with astigmatism, accommodation was not properly directed relative to the orientation of the image they were viewing. They did not distinguish between horizontal and vertical stripes in terms of focus adjustment. Their accommodative response was identical regardless of pattern orientation. It would be expected that the eye, in an attempt to achieve maximum visual clarity, would adjust focus depending on the direction of the lines, but this did not occur in these infants. Furthermore, rotating patterns also failed to trigger an adequate focus change. This indicates that the visual system of infants with astigmatism at this developmental stage does not

recognize image orientation as a relevant signal for initiating accommodation. These results suggest that the basic mechanisms of accommodation function from the earliest months of life, but that specific refractive errors such as astigmatism can significantly influence the manner and efficiency of that adjustment.

Maxwell, Tong and Schor (2012) examined whether the speed of ocular accommodation—that is, the ability to rapidly and accurately focus on objects at different distances—could be improved through targeted visual training. The results showed that most participants experienced a marked improvement in accommodation speed after completing the training. For example, the average accommodation speed for 2.5-diopter changes increased from 5.1 to 6.2 diopters per second, representing an increase of approximately 24 percent. Another interesting finding was that participants who initially had high accommodation speeds showed smaller improvements than those who began with lower values. This confirms the idea that training is most effective in individuals with weaker initial abilities. It was also observed that the most experienced participants—those who had previously taken part in similar research—exhibited the most stable and fastest responses, confirming the influence of prior experience and learning.

The results of the study conducted by Schaeffel, Wilhelm and Zrenner (1993) demonstrated that accommodation speed decreases with age. The youngest participants (children) reached accommodation speeds up to 21.7 diopters per second, while adults showed significantly lower speeds. A similar decline was observed in the speed of shifting focus from near to far. Specifically, the maximum accommodation speed for a 5-diopter target ranged from 21.7 diopters per second (for far-to-near accommodation) and even 32.7 diopters per second (for near-to-far accommodation) in children, to only 2.18 diopters per second in adults. Interestingly, in most participants, near-to-far accommodation was faster than far-to-near accommodation. The authors also examined the pupillary response—that is, pupil constriction during accommodation. In children under the age of ten, this response was nearly absent even with large accommodative demands (10 diopters), whereas in older individuals it became increasingly pronounced. In participants over the age of 40 it was observed that, despite complete loss of accommodation ability, the pupils still responded. Although the authors expected a relationship between refractive errors and accommodation dynamics, they found no correlation between accommodation speed and type of refractive error. On the other hand, the pupillary response was found to be weaker in myopic individuals compared with hyperopic and emmetropic individuals, even when all wore appropriate corrections during testing.

Culhane and Winn (1999) investigated whether there is a difference in the eye's ability to quickly focus on targets at varying distances—that is, whether differences exist between individuals with normal visual acuity and those with myopia. A specific goal of the study was to determine whether the duration of prior near viewing affects the speed and quality of the accommodative response, and whether these effects differ depending on the type of refractive error. The study included 21 participants divided into three groups: individuals with normal visual acuity, individuals who developed myopia in childhood up to the age of 14, and individuals who developed myopia later during adolescence or adulthood. Visual targets were suddenly shifted from near to far distances and vice versa, and the researchers measured how

quickly and efficiently the eye responded to these changes. Before each shift, participants were instructed to fixate on a point for 10, 60, or 180 seconds, in order to assess how the duration of prior fixation influenced the subsequent response. The results showed that individuals who developed myopia later in life exhibited significantly slower accommodative responses after prolonged periods of near viewing, particularly when they needed to quickly shift focus from near to far. In these individuals, the time required to shift from near focus to far focus increased considerably after 180 seconds of fixation. On average, it reached as much as 2.12 seconds, compared with 1.18 seconds in individuals with normal visual acuity and 1.19 seconds in those who developed myopia earlier in childhood. In individuals with normal visual acuity, as well as in those who developed myopia at an early age, such problems were not observed—their focusing speed remained stable regardless of the duration of prior fixation.

In the study conducted by Ghouschi, Prieto and Artal (2019), the authors investigated whether there is a difference in accommodation speed between individuals with normal visual acuity and those with varying degrees of myopia. The results showed that the average accommodation speed was 3.6 diopters per second, but individual values varied substantially—some participants showed speeds of only 2.1 diopters per second, whereas others achieved up to 5.5 diopters per second. This points to significant inter-individual variability even among individuals of similar age and refractive status. Further analysis revealed a relationship between accommodation speed and refractive error, as well as between accommodation speed and age. However, age appeared to have a stronger influence than refractive error, suggesting that these two variables may be interrelated and that their effects are difficult to distinguish in small samples.

In the study by Ghouschi, Mompeán, Prieto and Artal (2021), one of the main objectives was to determine whether there is a relationship between the degree of myopia and the speed of the accommodative response. However, the results did not show a statistically significant relationship between these two factors. Nevertheless, the authors observed that individuals with higher degrees of myopia often had a more pronounced “accommodative lag”—that is, a delay in focus adjustment, particularly when shifting from far to near. It was also noted that these individuals exhibited slightly slower pupil constriction responses. The authors observed that certain physiological functions occur in interrelation. For example, when accommodation was faster, changes in eye convergence and pupil reactions occurred more rapidly. This indicates that the visual system operates as a coordinated whole, with different mechanisms working in synchrony to ensure clear and stable vision.

This paper sought to determine the significance of accommodation speed, the methods used for its assessment, and the differences in accommodation speed between emmetropic individuals and those with refractive errors. It also aimed to identify changes in accommodation speed with increasing age.

Accommodation speed is essential for maintaining clear vision in everyday life, as it enables an individual to focus on objects that change rapidly—particularly in terms of distance, such as during reading or shifting gaze between near and distant objects.

The results of the reviewed studies clearly indicate that accommodation speed is a dynamic function of the eye that changes significantly with age, as well as depending on an

individual's refractive status. Research conducted across different age groups has confirmed that younger individuals possess higher accommodation speed compared with older individuals, which aligns with existing knowledge on progressive stiffening of the crystalline lens and reduced elasticity of the ciliary muscle with age. This is supported by the findings of Schaeffel et al. (1993), who reported that children can reach accommodation speeds of up to 21.7 diopters per second for far-to-near accommodation and up to 32.7 diopters per second for near-to-far accommodation, whereas values in adults dropped below 3 diopters per second. Studies further indicate that not only accommodation speed but also accuracy and coordination with other ocular functions—such as the pupillary response and convergence—are important. According to Ghouschi et al. (2021), these functions occur in a highly synchronized manner, confirming that the accommodative system cannot be viewed in isolation, but rather as part of an integrated visual response.

The question of how refractive errors affect accommodation speed remains open, given that different studies have produced differing results (Culhane & Winn, 1999; Ghouschi et al., 2019; Ghouschi et al., 2021). Some studies (Culhane & Winn, 1999; Ghouschi et al., 2019) pointed to slower responses in myopic participants, particularly after prolonged near work, whereas other studies, such as the 2021 study by Ghouschi et al., did not find a statistically significant association between the degree of myopia and accommodation speed. However, despite this, the presence of an “accommodative lag” in individuals with higher myopia was recorded, which may have clinical relevance in assessing visual fatigue and discomfort during prolonged near-work tasks.

An interesting finding is that response speed can be improved through specific visual training, as shown in the study by Maxwell et al. (2012). The improvement of approximately 24% after training indicates the plasticity of the accommodative system, particularly in individuals with initially weaker capacity. This finding opens possibilities for the application of visual therapies in clinical practice, especially in children and young individuals with symptoms of accommodative inflexibility.

CONCLUSION

Accommodation, as mentioned in the introductory section of this paper, is the eye's ability to clearly focus objects at different distances, thereby enabling distance and near vision. This process occurs within a very short time interval; however, it is known that its efficiency decreases with age. In addition to the physiological decline in accommodative ability caused by aging, various refractive errors, such as myopia or hypermetropia, affect the speed of accommodation. In such cases, delays occur in the so-called reaction time of the eye when shifting focus between different viewing distances.

The reviewed studies show that younger individuals have faster accommodation than older ones, and that myopes exhibit poorer accommodative speed compared to emmetropes. By examining the research included in this paper, we conclude that accommodative speed is important for people during everyday activities, particularly in tasks requiring rapid shifts of focus from one object to another.

The fact that this review paper relies almost entirely on international literature indicates that the availability of studies written within our region is scarce, which creates space for more extensive research on this topic in our local context.

REFERENCES

1. Allen, M. J. (1956). The influence of age on the speed of accommodation. *Optometry and Vision Science*. 33(4), 201-208.
2. Biga, S., Blagojević, M., Cvetković, D., Litričin, O., Parunović, A., Savićević, M., Tomašević, M. (2009). *Oftalmologija*. Beograd: Elit medica.
3. Bodakoš, K. (2024). *Analiza kirurških tehnika u liječenju kratkovidnosti* (Diplomski rad). Osijek: Sveučilište Josipa Jurja Strossmayera u Osijeku, Medicinski fakultet Osijek. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:152:485635>
4. Campbell, F. W. i Westheimer, G. (1960). Dynamics of accommodation responses of the human eye. *Journal of Physiology*. 151(2), 285–295.
5. Culhane, H. M. i Winn, B. (1999). Dynamic Accommodation and Myopia. *Investigative Ophthalmology Visual Science*. 40(9).1968-1974.
6. Denić, I. (2011). *Presbiopija - Staračka dalekovidost* (Stručni rad). Novi Sad: Prirodno-matematički fakultet, Departman za fiziku Univerziteta u Novom Sadu.
7. Gaćeša, S. (2023). *Usporedna analiza vidne oštine prije i nakon operativnog liječenja katarakte i ambliopije* (Diplomski rad). Koprivnica: Sveučilište Sjever. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:122:806786>
8. Ghouschi, V. P., Prieto, P., Artal, P. (2019). Speed of accommodation responses in myopes. *Investigative Ophthalmology & Visual Science*.60(9), 1791.
9. Ghouschi, V. P., Mompeán, J., Prieto, P., Artal, P. (2021). Binocular dynamics of accommodation, convergence, and pupil size in myopes. *Biomedical Optics Express*.12, 3282-3295.
10. Glavaš, S. (2018). *Povezanost prezbiopije i starost pacijenta* (Stručni rad). Novi Sad: Prirodno-matematički fakultet, Departman za fiziku Univerziteta u Novom Sadu.
11. Halauš, A. (2017). *Lasersko skidanje dioptrije - uloga i zadaća medicinske sestre* (Završni rad). Bjelovar: Veleučilište u Bjelovaru. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:144:136371>
12. Howland, H. C., Dobson, V., Sayles, N. (1987). Accommodation in infants as measured by photorefracton. *Vision Research*. 27(12), 2141–2152.
13. Ivanišić, I. (2015). *Oklo kao optički instrument* (Završni rad). Osijek: Sveučilište Josipa Jurja Strossmayera u Osijeku, Odjel za fiziku.
14. Jurinić, M. (2017). *Uloga refrakcijske kirurgije u liječenju refrakcijskih grešaka* (Diplomski rad). Zagreb: Sveučilište u Zagrebu, Medicinski fakultet. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:105:034823>
15. Jurinić, M. (2017). *Uloga refrakcijske kirurgije u liječenju refrakcijskih grešaka* (Diplomski rad).Zagreb: Medicinski fakultet Sveučilišta u Zagrebu.
16. Kalauz, M., Lukenda, A., Kordić, R., Kuzman, T. (2010). Refrakcijske anomalije i tretman u adolescenciji. *Medicus*. 19 (1_Adolescencija_2), 61-66.

17. Karaahmetović, A. (2012). *Uticaj presbiopije na kvalitet života* (Stručni rad). Novi Sad: Prirodno-matematički fakultet, Departman za fiziku Univerziteta u Novom Sadu.
18. Kovač, R. T. (2024). *Suvremeni pristup korekciji presbiopije* (Diplomski rad). Zagreb: Sveučilište u Zagrebu, Medicinski fakultet. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:105:953515>
19. Marković, A. (2015). *Hipermetropija u prezbiopnoj populaciji* (Stručni rad). Novi Sad: Prirodno-matematički fakultet, Departman za fiziku Univerziteta u Novom Sadu.
20. Maxwell, J., Tong, J., Schor C.M. (2012). Short-term adaptation of accommodation, accommodative vergence and disparity vergence facility. *Vision Research*. 62(1), 93-101.
21. Pallikaris I. (2020). Emmetropia - The perfect imperfection. *Indian journal of ophthalmology*, 68(12), 2656–2659.
22. Parkinson, J., Linthorne, N., Matchett, T. (2001). Subjective measurement of the near point of accommodation in pre/early literates. *The American Orthoptic Journal*. 51(1), 75-83.
23. Paulik, A. (2018). *Problemi vizualnog funkcioniranja kod djece s teškoćama u savladavanju odgojno-obrazovnih sadržaja* (Diplomski rad). Zagreb: Sveučilište u Zagrebu, Edukacijsko-rehabilitacijski fakultet. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:158:927574>
24. Pikula, A. (2020). *Akomodacija kod emetropnog i ametropnog oka* (Završni rad). Novi Sad: Prirodno-matematički fakultet, Departman za fiziku Univerziteta u Novom Sadu.
25. Romić, D. (2020). *Analiza čimbenika pseudoakomodacije nakon ultrazvučne operacije mrežne i ugradnje jednojakosne intraokularne leće* (Diplomski rad). Osijek: Sveučilište Josipa Jurja Strossmayera u Osijeku, Medicinski fakultet Osijek. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:152:808646>
26. Schaeffel F, Wilhelm H, Zrenner E. (1993). Inter-individual variability in the dynamics of natural accommodation in humans: relation to age and refractive errors. *Journal of Physiology*. 461, 301–320.
27. Schor, M. i Bharadwaj, S.R. (2005). Pulse-step models of control strategies for dynamic ocular accommodation and disaccommodation. *Vision Research*. 46(1-2), 242-258.
28. Stanojević, K. (2012). *Prezbiopija - Savremeni dijagnostički i terapijski modaliteti* (Stručni rad). Novi Sad: Prirodno-matematički fakultet, Departman za fiziku Univerziteta u Novom Sadu.
29. Teskeredžić, A. i Tulumović, Š. (2013). *Biotičke osnove i dijagnostika vidnog analizatora*. Tuzla: Off-set.
30. Tomljanović, N. (2022). *Kirurška korekcija refrakcijskih grešaka* (Diplomski rad). Zagreb: Sveučilište u Zagrebu, Medicinski fakultet. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:105:157803>
31. Tomljenović, R. (2018). *Metode korekcije kratkovidnosti* (Diplomski rad). Zagreb: Sveučilište u Zagrebu, Medicinski fakultet. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:105:797781>
32. Tulumović, Š. (2018). *Funkcionalna procjena osoba oštećena vida*. Tuzla: IN SCAN d.o.o. Tuzla.

33. Tulumović, Š. i Teskeredžić, A. (2019). *Dijagnostičko-korekcionni postupci u rehabilitaciji vida*. Tuzla: IN SCAN d.o.o. Tuzla.
34. Vargas, V., Radner, W., Allan, B. D., Reinstein, D. Z., Dick, H. B., Alio', J. L. (2019). Methods for the study of near, intermediate vision, and accommodation: an overview of subjective and objective approaches. *Survey of Ophthalmology*. 64(1), 90-100.
35. Vratarić, V. (2020). *Nove tehnologije u operaciji oka- uloga medicinske sestre* (Završni rad). Zadar: Sveučilište u Zadru. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:162:465251>
36. Vukić, V. (2018). *Rezultati testiranja vidno evociranim potencijalima u liječenju slabovidnosti isključivo okluzijom* (Diplomski rad). Split: Sveučilište u Splitu, Medicinski fakultet. Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:171:378602>
37. Zeljković, M. (2013). *Staračka dalekovidost – Presbiopija* (Stručni rad). Novi Sad: Prirodno-matematički fakultet, Departman za fiziku Univerziteta u Novom Sadu.
38. Win-Hall, D.M. Glasser, A. (2008). Objective accommodation measurements in prepresbyopic eyes using an autorefractor and an aberrometer. *Journal of Cataract and Refractive Surgery*. 34(5), 774-784.