Relaxed Vision

A clinical study

Evaluation of the effect of osteopathic treatment on symptoms caused by asthenopia

Master Thesis to obtain the degree

Master of Science (Osteopathy)

at the **Donau Universität Krems**

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Translated by Mag. Barbara Schnürch

DECLARATION

Hereby I declare that I have written the present master thesis on my own.

I have clearly marked as quotes all parts of the text that I have copied literally or rephrased from published or unpublished works of other authors.

All sources and references I have used in writing this thesis are listed in the bibliography. No thesis with the same content was submitted to any other examination board before.

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Date Signature

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Preface

First of all I would like to seize the opportunity to express my thankfulness. I would like to thank three groups of persons in particular. People, without whom it would not have been possible to write this master thesis.

First of all my thank goes to my companion in life Andrea, my family, in particular my mother Ursula and my sister Maria and brother Ulrich and all my friends. With the utmost respect and extraordinary empathy these persons have put their own interests on hold in order to give me the time and space to finish this paper.
The trust and love I experienced during this time cannot be valued more – and from the bottom of my heart I would like to express my sincere gratitude.

The second group of persons whom I would like to thank are the persons who made sure that this paper meets the highest standards with regard to content and also from an organizational point of view.
In this context I would like to mention first of all my tutor Mag. Kathie Musil, who helped me with words and deeds to stay on track and who never tired to motivate me to make the best out of this work.

The idea of this project I owe to Thomas Aigner who is an optician and was the first one to refer a patient to me whose main problem was “impaired vision”. In the case of this patient he had considered all possible forms of therapy proposed by the compendium of the General Hospital (AKH-Consilium (2006)) with the exception of an operation and did not know what to do anymore as an optician.
The patient was a ten year old boy with marked myopia on both eyes (-11 dioptres) and 9 prisms in both glasses. Practically, the only option left for him was an operation. Equipped with some techniques I had the privilege to learn from Hanneke Nusselein during my training and the knowledge I had acquired myself I started to treat the eyes of this young boy.
In the first session I noticed a pronounced lesion of the SBS and several structural restrictions in the upper cervical segments, the region of the cervicodorsal junction, the hip and the liver. Abiding by the principle “the human body works as an entity” I treated not only the boy’s eyes and the lesion of the SBS but also all other problems his mechanism had to fight.

The result was a clear improvement of the boy's condition. The dioptres were significantly reduced from -11 to -3.5 and also the prisms could be reduced from 9 to 0. Thus my interest was raised and I started to further investigate the topic.

Without this first referral I probably would not have considered this wonderful osteopathic topic.

Mag. Claudia Tanzer took on the statistical analysis of the data for which I am particularly grateful. Only her love of detail made sure that the clinical analysis is what it is now.

The fact that I was able to recruit the unbelievable number of 280 test persons, who were drawn in an ad hoc sample - I owe to the unremitting efforts of Ms. Bernardi who was a great support in the organization of the treatments and distribution of questionnaires.

Dr. Karin Dertl carried out the medical examinations before and after the treatment. Despite being exposed to a lot of time constraints like all medical specialists she sacrificed her free time to carry out the time-consuming examinations and was at all times a competent and caring partner for me.

I would also like to thank my translator Mag. Barbara Schnürch, who agreed to translate this paper despite the tight time schedule and thus made it possible to hand in the thesis in due time. In addition, she was the "voice" of our teachers throughout the whole osteopathic training and passed on the philosophy of these great personalities with interest and enthusiasm.

The third group of people I owe my deepest gratitude are all those who are responsible for anchoring osteopathy deep in my heart. This includes all the teachers I had the privilege to learn from. I cannot list all but I would like to mention Bernard Ligner and Hanneke Nusselein as representatives of all the others. Thank you for the great gift you made to me – osteopathy.

1 Abstract

1.1 Hypothesis

Can osteopathic treatments influence asthenoptic complaints in a positive way?

1.2 Study design

This experimental clinical study is organized as **pretest-postest control group design** and thus belongs to the group of **pragmatic randomized controlled studies**.
The **ad hoc – sample** (not randomized sampling) which was carried out at the Hauptschule Timelkam (compulsory secondary school) comprised 280 test persons.
All received a questionnaire, 72 were returned, 40 met the inclusion criteria, but only 26 could be included in the statistical analysis.

1.3 Primary outcome measure

The **questionnaire** to identify asthenoptic complaints served as primary outcome measure. Since the diagnosis asthenopia represents only a description of symptoms this approach seemed only logical to me.

1.4 Secondary outcome measure

The ophthalmologic examination and the resulting data were determined as secondary outcome measure.

1.5 Inclusion criteria

This study includes only those test persons who returned a positive questionnaire (Hettrich (2002)) on the subjective problems of asthenopia.
The questionnaire is regarded as positive if ‘5’ is marked once or several times, ‘4’ is chosen three times or more often, or ‘3’ is given six or more times as an answer.

1.6 Exclusion criteria

Patients with pathological eye conditions were excluded, but none of the test persons suffered from a pathology.

1.7 Implementation of the study

Two homogenous groups which meet the inclusion criteria are formed.
The control group (12 test persons) is examined by an ophthalmologist at the beginning of the study period, if necessary glasses are adapted, and after 7 weeks the children come to a second ophthalmologic examination.
The study group (14 test persons) is also examined by an ophthalmologist at the beginning of the study period and glasses are adapted if necessary. Within the study period of 7 weeks the children in the study group receive three osteopathic treatments. After that they are once more examined by the ophthalmologist.
The osteopathic treatment is delivered during regular class time. Treatments took place in a special room of the secondary school Timelkam.
The ophthalmologic examinations took place in a doctor's practice.

1.8 Measuring instruments

Basically, the measuring tools used in this study can be divided into two categories:

1. Questionnaire (evaluation of the subjective perception)
2. Ophthalmologic measuring instruments and tools for diagnosis (valid data)
    a. Visus examination (measurement of visual acuity without refraction)
    b. Sciascopy (measurement of visual acuity with refraction)
    c. Measurement of accommodation
    d. Lang stereo-test (test of strabismus)
    e. Funduscopy (examination of the back part of the eye's interior to exclude pathologies)

1.9 Criteria of the questionnaire

The questionnaire comprises 25 questions which can be answered on a 1-to-5 scale, with '1' meaning 'not true' and '5' meaning 'absolutely true'.
14 questions have to be answered by the parents, the remaining 11 questions by the children.
The questionnaire was developed by Schroth (2003) and is used by orthoptists in Germany to evaluate asthenoptic complaints.
To obtain more significant results the questions were divided in the categories 'reading', 'writing', 'concentration', 'observable physical overstraining symptoms', 'gross motor skills' and 'fine motor skills'.

1.10 Relevance for osteopathy

The term asthenopia summarizes a number of symptoms like impaired near accommodation, blurred vision, rapid fatiguing, double vision, “dancing” letters, burning and watery eyes, headaches/migraine, dizziness, nausea, bad position of the head, squinting, blinking, deteriorating eyesight, dyslexia (reading/writing difficulties) and ADHD. (Saber, 2005; Hettrich, 2002; AKH-Consilium 2006)
So far only ophthalmologists and opticians/orthoptists have been concerned with the treatment of asthenopia.
But this field of ophthalmology could also open up for osteopathy.

1.11 Results

Due to the high drop-out rate of participants the results of this study are statistically not significant. Nevertheless, some carefully formulated tendencies can be identified.
The results show that in most examined categories, which are evaluated by the questionnaire, an improvement of the subjective complaints could be observed.
Both the parents and the children of the study group identify much greater and more positive changes than the parents of the control group.
This observed tendency could speak in favour of the osteopathic treatment method.

A comparison of the measurements of the children’s myopia, emmopia and hyperopia in the course of ophthalmologic examinations before and after the osteopathic intervention showed no statistically significant differences between the study group and the control group. As regards accommodation the tendency of a slight improvement might be identifiable, which again could speak in favour of osteopathic treatment.

1.12 Conclusions

Summarizing it can be said that the parents and children of the study group rated all categories after the intervention better than the parents and children after the study period of seven weeks without treatment.

This could provide some evidence that asthenoptic complaints can be influenced positively by osteopathic treatment.
Due to the high drop-out rate among the participants, however, the results are **statistically not significant** to support the hypothesis of this thesis.

2 Introduction

Function and structure are two buzzwords that are inseparably connected in osteopathy. These two terms appear in all fields of our manual art and they represent one of the 5 cornerstones of the osteopathic philosophy.
(Still, 1902)

The **function** of the optic apparatus is the sensory process of seeing. It takes place in the brain where the images perceived by both eyes are fused to form one image. (Lang, 1995)
The **structures** which make this process possible are the muscles that can move the eyes in opposite directions. This motoric interaction is triggered by a fusion stimulus which is called **vergence**. (Lang, 1995)
Accomodation (Lat. *accomodare* "to adapt, adjust, apply, fasten on") describes the ability to change the optic refraction power of the eye's lens. This mechanism serves the purpose to change the direction of the light entering the eye so that a sharp image of objects in different distances can be formed on the retina. (Lang, 1995)

Within the framework of my final thesis I have posed myself the question: "What are the symptoms of bad eyesight (asthenopia) and can osteopathy do something about it?"

Inspired by Thomas Aigner, a friend who is an optician and optometrist, I wanted to explore the "eyes" more thoroughly and found a medical diagnosis which is the closest approximation to the condition of bad eyesight and especially the symptoms of bad eyesight – **asthenopia**. (Lang, 1995; Hettrich, 2002; Gordes, 2005; Rössler, 1941; Vranko, 2001; Saber, 2005)

Asthenopia is a collective term for a number of muscular and neurogenic pathologies. Hettrich et al (2002) offer the following descriptions of symptoms in their orthoptic list of indications:

- Visual problems
    - Blurred vision
    - Rapid fatigue
    - Double vision
    - "Dancing" letters
- Burning and watery eyes
- Headaches/migraine
- Pain inside or behind the eyes, in the frontal region
- Dizziness
- Nausea
- Bad position of the head
- Sensitivity to light, squinting or blinking
- Deterioration of vision
- Stress symptoms
- Psychic changes
- Refraction errors that need correction

Hettrich et al (2002) write in the introduction:

"The term asthenopia summarizes various complaints and problems linked with the process of seeing. In a seemingly regular eye asthenoptic complaints are very varied and do not permit a clear conclusion as to their direct causes. Due to this fact a diversity of symptoms occurs, symptoms which often increase when the eyes are strained or have to work over longer periods. Asthenoptic complaints can considerably affect a person in his/her physical and mental wellbeing. Therapy tries to restore the patients' normal performance and vitality. In times of growing visual stress (e.g. due to computer work) the diagnostic and therapeutic possibilities of orthoptists gain more and more in importance with regard to this complex of symptoms."

Hettrich (45:2002)

In comparison with Hettrich (2002) the Medical University of Vienna provides the following definition of asthenopia in its latest AKH-Consilium compendium (2006):

- Symptoms
    - Heaviness of the eyelids, itching, burning, rapid fatiguing, blurred vision, dull eye pain, especially in cases of close distance work, headaches, temporary double vision
    - Complaints are not present in the morning but appear only over the course of the day and increase progressively due to straining of the eyes

- Causes
    - Dioptric asthenopia
        - In the case of refraction errors
    - Artificial asthenopia
        - Due to wrong correction with glasses
    - Muscular asthenopia
        - Due to a disturbed balance of the eye muscles
    - Nervous asthenopia
        - Due to functional disturbances if no abnormality is detected

As regards the treatment of asthenoptic complaints the AKH-Consilium compendium 2006 recommends:

- Dioptric asthenopia in the case of refraction errors
    - Correction with glasses after preliminary test of refraction with cycloplegia (elimination of accommodation)
- Artificial asthenopia due to wrong correction with glasses
    - Check of glasses and position of glasses (centering)
- Muscular asthenopia due to imbalance in the eye muscles

        - Fusion and convergence exercises; possibly prism correction or eye muscle surgery

    - Nervous asthenopia as purely functional disturbance if no abnormality is detected
        - Symptomatic treatment; tone-raising eye drops, eye drops containing digitalis
        - Treatment of the overall state of health

Both definitions emphasize the correlation between vision and the physical symptoms in the whole body which are caused by an overstraining of the eyes. Thus both definitions serve as basis for diagnosing asthenopia and therefore represent the background of this master thesis.

It has to be pointed out that the treatment approaches recommended in the AKH Consilium compendium focus exclusively on the eye itself, thus the eye itself is seen as the only origin of the problem. This does not correspond with Hettrich's opinion (2002). He writes that the asthenoptic complaints are quite diverse and thus do not permit a clear conclusion about what is the direct cause of the problem.

Also Gordes (2005) emphasizes the problem of recognizing the cause of the complaint, an opinion that reflects the controversy among medical specialists. In her research report she writes about how difficult it is to establish a diagnosis and provide a therapy for asthenopia:

"The diagnosis and therapy in the case of compensation through accommodative convergence (asthenopia) are difficult to find and very time-consuming. Despite the fact that in our experience this is the most common cause for complaints leading to reading problems, it is to a large extent unknown."

Gordes (384:2005)

Confronted with these statements and the apparent difficulty to explain the cause of asthenoptic complaints, I started to research the problem in an osteopathic context.

I found something interesting by Bates (1999) who challenges the lens as being the main cause of bad eyesight in his work. He thinks to have found out that accommodation is not only influenced by the lens and the M. ciliaris controlling the lens but also by the 6 extrinsic muscles of the eye.
He proved this in a remarkable experiment where he surgically removed the lens of rabbits and observed after a period of four weeks when the wounds had healed that accommodation (measured by means of a retinoscope) can still be effectuated. Bates called this phenomenon **extrinsic muscle accommodation.**

Sobotta (2002) describes the N. oculomotorius (III) as the nerve that supplies the M. ciliaris parasympathetically and thus is responsible for controlling the stretching or relaxing of the lens, i.e. accommodation of the eye.

With the above mentioned experiment Bates (1999) proved exactly the opposite. He writes:

"Thereafter, for a period extending from one month to two years, electrical stimulation always produced accommodation in the lens-less eye precisely to the same extent as in the eye which had a lens."

Bates(1999: 45)

His conclusion was that accommodation is possible also without lens. Thus not only the N. oculomotorius can be responsible for accommodation. Bates attributed a similar importance in changing the refractive power also to the N. trochlearis. He writes:

"When either the third or the fourth nerve was stimulated with electricity near its point of origin in the brain accommodation always resulted in the normal eye."

Bates(1999: 45)

If thus the adaptation of the eye to objects in different distances cannot only be controlled by the M. ciliaris, the lens or the supplying nerves, but if also the N. trochlearis, which according to Sobotta (2002) has a pure motoric function, plays a role in the accommodation of the eye, the osteopathic principle – the **structure governs** the **function** and the **function** forms the **structure** – can be applied in patients suffering from asthenopia.

2.1 Background in the literature

It has to be pointed out that in this master thesis gender specific terms will be used where appropriate.

The fact that accommodation is not only depending upon the function of the nerve (N. oculomotorius) supplying the M. ciliaris and the lens, was already discovered by Davis 1895. In a report he writes about removing a cataract in the eye of a 42-year-old male patient on January 27, 1894, and releasing the patient from hospital with the at the time usual lens substitute, i.e. hyperopic glasses of + 11.5 dpt and even stronger myopic glasses. Nine months later the patient came to see him again, not because of pain but because he was afraid he could "overstrain" his eyes. The patient told Davis that a few weeks after the operation he had lost his reading glasses and thus was wearing only the hyperopic with which he could read without any problems.
An ophthalmologic check-up showed that the patient could read the 3m line of the eye chart from a distance of 6m with his lens-less eye and that he was even able to read the smallest print from a distance of 35 to 45cm with the same glass so that no change of position or glass was necessary.
This meant that the eye of the patient was able to accommodate far and near without the lens. (Davis, 1895)

In one of his studies also Rössler (1941) describes that an excessive or lacking accommodation of the eye and visual acuity are not necessarily directly correlated. In a series of experiments he wanted to examine the accommodation ability of a normal eye with the aid of a cobalt lamp. He thus excluded all test persons who due to local or general examination findings could be expected to have a pathological response to the accommodation stimulus.
In a second experiment Rössler examined the accommodation ability of all cases (41) that were regarded as pathological. In comparison to the "normal group" (14 myopic test persons, 15 emmopic test persons, 12 hyperopic test persons) he could not detect any significant differences.
The only difference he was able to perceive was: "*...an extraordinary readiness to accommodate!" (Rössler 348:1941)*

According to him this would justify the pain symptoms mentioned in the introduction.
In the summary he writes:

“ ...; the actual causes (of asthenopia) are the pathologically altered reactions and functional processes of certain phylogenetic and ontogenetic mechanisms of the brain due to disturbances of the psycho-vegetative system because of defective formation or organic diseases.

Like a paralysis or an overstraining of the convergence apparatus can lead to a strabismus caused by the central nervous system, a paralysis or overstraining of the accommodation can lead to asthenopia.”

Rössler (359:1941)

Already in 1941 Rössler assumed that not only the lens is responsible for the excessive accommodation of an asthenoptic eye but the cause has to be searched also elsewhere. However, he did not explain this in more detail.

In my search for possible other causes of lacking or excessive accommodation I found an interesting explanation by Carreiro (2004).
In her book “Pädiatrie aus osteopathischer Sicht” Carreiro explains a correlation between body posture and pathological accommodation.
The body adapts to pathological conditions by coupling the ocular and vestibular systems. This means that the brain of a child, who has a different refraction power in both eyes, will tell the body and the muscles to compensate for this. Now if balance problems or a faulty posture can be found in such a child, this could be deducible from a misinformation of the proprioceptive mechanoreceptors in the neck and lower back. The reason for that is, however, that the brain wants to see “straight”. (Carreiro, 2004)

This can have far-reaching consequences. According to Vranko (2001) asthenoptic complaints in this context occur when the body has to try harder to compensate for such an incorrect vision or posture.

Faulty vision or position of the eyes can impair the visual perception and the efficiency of the functions of seeing and thus have an influence on the learning or reading (Vranko, 2001).

An increased straining of the muscles can affect the tension of the supplying vessels.
This conclusion is supported by Gorman (1995). In a single case study he proved that lesions of the cervical spine can lead to **problems of blood circulation** of the eye caused by **micro-spasms**. A targeted manipulation of the cervical spine can release these spasms, which also improves the eyesight. The author uses computer-assisted optometry as independent variable. Since this study was carried out as single case study without control group, the result has to be taken with a grain of salt, because it is not possible to draw any generally valid conclusions on the basis of the results of just one test person.

2.2 Osteopathic clinical studies

This chapter will present osteopathic theories concerning the treatment of the eye and the connections of the eye with the rest of the body.

In her clinical study Grifman (2003) examined the correlation between the vergence of the eyes and lesions of the upper cervical segments. All 31 test persons had normal binocular eyesight and at least one lesion in the upper cervical spine. After randomization into two groups the test persons of the experimental group received a treatment of the upper cervical spine with Balanced Ligamentous Tension techniques, high velocity thrusts and muscle energy techniques. The patients of the control group spent 10 minutes lying on the treatment table. Grifman could not detect a significant change of the vergence both in the control group and the experimental group. But she points out that by treating only the cervical spine possible negative influencing factors of the cranial base or orbit were not adequately treated.

Griffman based her treatment approach on a study by Tricots (1992) who found out in clinical examinations that if a patient moves his/her eyes to the right, C2 and the occiput do a right rotation and the SBS features a left torsion. He explained his palpation results with the mechanical attachment of the dural membranes in the cranium and the upper cervical spine. Specifically, they exert a traction force on the greater wings of the sphenoid which has a direct influence on the SBS and C2/3 through the dural attachment. The atlas acts like a disc that “floats” between the cranial base and C2. In addition, he found out that in the presence of an SBS lesion the mobility of the atlas and of the eyes is restricted.
In his study Tricot compared the mobility of the atlas in patients who were relaxed with that of patients whose eyes were moving. Besides the objection that palpation is no valid measuring tool in scientific work, the conclusion that the atlas has more mobility if the patient is relaxed is not surprising.
But what is interesting is the supposedly important role that the atlas plays for the movement of the eyes.

Ham, Heijden and Isaak (2004) examined whether it was better to treat eye problems with a singular technique or whether it would make more sense to apply a comprehensive osteopathic approach.. The authors looked at the effect of osteopathy on squinting. 36 test persons were divided into four groups with the group T0 receiving no treatment, T1 a singular

osteopathic intervention (left sphenoid), T2 a limited osteopathic treatment (cranium), and T3 a comprehensive osteopathic treatment. In 95 % of the test persons in group T3 the squinting improved by an average of 4.1%. This result sounds quite good but in an objective assessment of this study one has to point out the small number of participants. In his review of the study K. L. Resch writes in the "DO - Deutsche Zeitschrift für Osteopathie":

"If we allege that the topic was chosen due to deliberate calculation (an indication for that can often be found in osteopathic literature and is conspicuously often commented in a positive way), the rest of the study worked out almost better than allowed. The fact that only 36 children were divided in four different groups, lets every statistician break out in cold sweat because mere coincidences can conceal true effects or feign wrong effects."

Resch (2/2005:6)

But a strict methodology was observed and according to Resch the authors of the study worked in a highly professional and systematic way, thus my paper will serve as one of the bases of my paper and as justification of the fact that I no limitations were applied as to the choice of techniques.

This study also confirms Still's paradigm "The human body works as an entity" and thus recommends to see the treatment of the eye in a more global context.

Also Pesendorfer (2002) shares the same opinion. In his work he looks at changes in the mobility of the locomotor system and the painfulness of certain trigger points after an osteopathic treatment of the eye in patients with myopia, hyperopia and astigmatism. His study included 20 patients who were divided into two groups. The experimental group was treated with structural techniques, intraosseous techniques, membranous techniques and muscle energy techniques, while the participants in the control group had to lie on the treatment table for 15 minutes.
Pesendorfer found partial but significant improvements of the joint mobility in the experimental group. The osteopathic treatment also reduced the painfulness of the trigger points by half. The author of the study explained the significant improvement of the mobility in the cervical spine through the anatomical connections he found during his work, especially via the sympathetic fibres of the autonomous nervous system which run from the cervical spine to the eye.

In his work Pesendorfer follows the best possible methodology available for osteopaths (mobility tests with previously marked distance points, subjective pain perception with MediMouse). He proves that the treatment of the eye improves the mobility of peripheral joints and the subjective pain perception of specific trigger points.

Summarizing we can say that an isolated treatment of the upper cervical segments does not lead to a change in vergence (Grifman, 2003), but it seems that the atlas plays an important role for the movement of the eyes (Tricot, 1992).
According to Hams, Jeijdens and Isaaks (2004) it seems that the best verifiable therapeutic effect can be achieved when the treatment of the eyes is put in an overall osteopathic context An improved mobility of peripheral joints and the reduction of pain perceived at specific trigger points after an osteopathic treatment of the eyes supports the theory of a possible link between the eye and the rest of the body (Pesendorfer, 2002).

2.3 Allopathic point of view and clinical studies

This chapter will take a closer look on the current allopathic attitude with regard to asthenopia. It has already been mentioned that there is agreement concerning the description of asthenoptic symptoms. However, there are different views concerning the possible causes of asthenoptic complaints. (Hettrich, 2002; AKH-Consilium, 2006)

Therefore experts commonly use terms like fixation disparity, associated heterophoria or in German “Winkelfehlsichtigkeit”, which offer a possible explanation for asthenoptic symsptoms. (London, 2006) (Görsch 1995) (Diepes, 2001)
Since the complexity of the topic would by far exceed the scope of this thesis, the aforementioned terms will not be explained in more detail.

Nevertheless, a brief overview of allopathic theories is indicated, especially because also allopathic medicine differentiates between motoric and sensory disturbances of visual perception and image transmission of the eyes.

Basically, accommodation (definition cf. Introduction) is a process which needs a degree of muscle energy. If ametropia in the form of hyperopia is present, the overall refraction power of the eye in relation to the eye’s length is too weak. Nevertheless the hyperoptic eye can completely or at least partially compensate for its ametropia through accommodation. (Lang, 1995)

This can lead to problems like blurred vision, dizziness, headaches, irritated eyes or sensitivity to light, which, however, can be easily resolved if the ametropia is corrected with glasses. (Diepes, 2001; Lang, 1995)

If the correction of refraction does not have the desired effect and visual problems still remain, a problem of binocular vision could be suspected. The precondition for binocular vision is called fusion. The term fusion designates the fact that the images of the right and left eye fuse to form one picture in the brain. Fusion can be schematically divided in two processes: **motoric fusion** (the action of muscles changes the position of the eyes) and **sensory fusion** (processing through interconnections in the brain makes the two images fuse to form one). (London, 2006)

When the eyes look at something in a distance their position is parallel to each other. Ideally all external eye muscles have the **same state of tension and innervation**. A common deviation from the ideal state is called “Winkelfehlsichtigkeit” in German or associated heterophoria. In the natural process of seeing the two eyes want to adopt a resting position which does not correspond to the ideal position: the result is a shifted image since motoric fusion cannot take place without an overstraining of the eyes. (Görsch, 1996; Gorzny 2005)

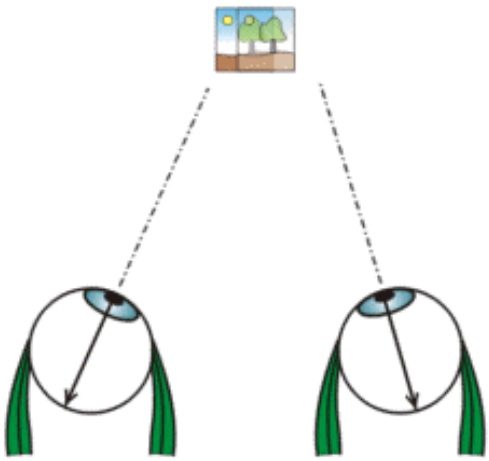


Figure 1: Condition in “Winkelfehlsichtigkeit” or associated heterophoria

Typical complaints due to the work of the muscles to compensate for “Winkelfehlsichtigkeit” are asthenoptic complaints. Children who suffer from this kind of problems get tired very quickly when reading because the necessary compensation uses a lot of energy. These children also do not like to watch television or play computer games and avoid anything that necessitates concentrated close vision for a longer period of time because an overstraining of the eyes increases the asthenoptic complaints. (Vranko, 2001)

The two eyes do not only resort to motoric fusion, they also take advantage of **sensory fusion** to save some muscle energy. Depending on the extent of the hidden misalignment of the eyes it can even happen that sensory fusion completely replaces the muscle action that is necessary to compensate for the hidden misalignment. The overstraining symptoms are less in this case but for the cost of a quite restless vision and reduced stereopsis. This adaptation is called fixation disparity. (London, 2006)

Typical visual problems in the case of a fixation disparity are restless close vision with changing focus, bad three-dimensional vision, sensitivity to light and/or temporary double vision, which again corresponds to the description of asthenoptic symptoms. (Saber, 2005; Hettrich, 2002; AKH-Consilium 2006)

Depending on the method and school of thought disturbances of binocular vision are either not considered at all or only the motoric aspect is corrected. If the measurment and correction method of H.-J. Haase is applied, both the motoric and sensory aspects of fusion are completely taken into account. According to this method prism glasses can reduce overstraining problems and improve the sensory function, which can be proven through subtle tests of three-dimensional vision. (Görsch, 1995)

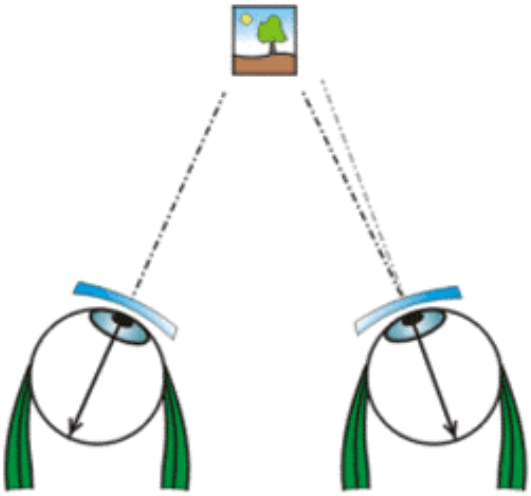


Figure 2: Correction with prism glasses

For opponents of this theory the complete sensory correction relieves the strain on the eye too much which can lead to a slow but progressive deterioration of accommodation and thus stereo vision. (Diepes, 2001)

Recapitulating, it can be stated that fusion has a motoric and a sensory aspect (London, 2006) and that asthenoptic complaints are always linked with an under- or over-accommodation (Rössler, 1941). “Winkelfehlsichtigkeit”, associated heterophoria or a fixation disparity can be regarded as possible causes. (Vranko, 2001; Görsch, 1996; Gorzny 2005; London, 2006)

The most common allopathic therapy for asthenoptic complaints is the correction of visual acuity in the case of dioptric asthenopia as well as the training of the eye muscles in the case

of muscular asthenopia (AKH-Consilium, 2006). Saber (2005) examined 61 girls and 59 boys aged between 6 and 16 who were recruited in a school in the vicinity of Stockholm. By means of a questionnaire the author of the study established that all test persons suffered from asthenoptic complaints.

Afterwards the participants had to undergo an ophthalmologic examination where the visual acuity of close and far vision (with and without cycloplegia), stereo vision and accommodation were measured. With the aid of funduscopy pathologies were excluded..

Saber obtained the following results:

Table 2. Main diagnoses and treatment

Diagnoses	No	Treatment	Symptom free	Reduced Symptom
Normal Ophthalmologic and Orthoptic Examination	11	Referred to Paediatrician	9	2
Suspected Eye Pathology	3	Referred to Paediatric Ophthalmologist	2	1
Accommodative Problems	49	Glasses +0.75 and +1.0	48	1
Hypermetropia	9	Glasses	8	1
Hypermetropia and Astigmatism	13	Glasses	12	1
Astigmatism	3	Glasses	3	–
Myopia	7	Glasses	7	–
Myopia and Astigmatism	9	Glasses	8	1
Exophoria, Esophoria and Vertical phoria	9	Prism Glasses	9	–
Exotropia, Esotropia and Vertical tropia	3	Surgery	3	–
Convergence Insufficiency	1	Exercises at home 5 trials 5 times/day	1	–
Convergence Insufficiency and Accommodative Problems	3	Exercises at home 5 trials 5 times/day Glasses +0.75 and +1.0	2	1
Total	120	–	112	8

Table 1: Study results of Saber

Saber (2005:69)

It is interesting that quite a large number of children suffer from hyperopia. In the summary Saber writes:

“Hypermetropia is generally accepted as on of the most important parameters in asthenopic problems. ... In this study we could find a correlation between the hypermetropia and asthenopic symptoms, and 59.1 % of the students with hypermetropia had visually related symptoms (group A), 9.1 % students with hypermetropia had headache (group B) and 31.8 % oft the students with hypermetropia had visual problems combined with headache (group C).“

Saber (2005:71)

It is interesting that 93 % of all children did not experience any pain after a period of 3 to 6 months and that in 7 % the symptoms improved.
Unfortunately, Saber does not mention in his article which scale he used to validly establish the subjective pain perception. Thus the almost unbelievable number of test persons who did no longer experience pain after a period of 3 to 6 months has to be regarded with some scepticism.
In addition, he did not have a control group due to ethical reasons, a fact which also reduces the validity of a clinical study.
Nevertheless, it can be said that exact measurements of the eyes and a therapy that is tailored to the needs of the individual patient can positively influence asthenoptic symptoms.

In the past few years asthenopia was examined more closely especially in Germany with regard to a possible correlation between asthenoptic problems and reading/writing difficulties or ADHD (attention deficit hyperactivity disorder).

Gorzny (2005) published a study in the trade journal of German opticians (DOZ), which I would like to mention as example of this category of studies.
Gorzny is an optician who carried out this study in his practice. The study included 118 children, 68.6% male and 31.4 % female test persons. The age of the participants ranged between 6 and 15 years and in all participants it was suspected that the eyes were somehow involved in reading/writing difficulties and ADHD. The following methods of measurement were used:

1. questionnaire (to evaluate the subjective perception of pain)
2. visus test (to evaluate visual acuity without refraction)
3. sciascopy (to evaluate visual acuity with refraction)
4. funduscopy (to exclude pathologies)
5. measurement and correction method of Haase (to detect fixation disparities)

In 82.8 % of the test persons he found a slight to moderate hyperopia. But with the differences in the visus test and the sciascopy no significant tendency that the eyes are involved in reading/writing difficulties or ADHD could be detected. This corresponds to a study by Schäfer (1997), which was quoted by Gorzny. This study was carried out in Würzburg involving 24 000 pupils and students and led to the same result.
Only with the polar test (measurement and correction method according to Haase) Gorzny could detect vergence problems that could be an explanation of writing/reading difficulties or ADHD.
His study led to the conclusion that routine eye check-ups (visus test, sciascopy, funduscopy) cannot detect a correlation with reading/writing difficulties or ADHD. Only the targeted use of the polar test can help to explain such problems from an ophthalmologic point of view.

In addition, it is noteworthy that two thirds of the test persons indicated impaired gross and fine motor skills. This result corresponds to Carreiro's findings (occulo-vestibular reflex) and Pesendorfer's research (changes in the mobility of the locomotor system) and underlines the enormous influence of the eyes on the whole body system.

2.4 Summary

Balance in the muscular and nervous supply of both eyes is necessary for relaxed vision. (Görsch, 1996; Gorzny 2005) This enables an undisturbed fusion of the image both on a motoric and sensory level. (London, 2006) The ability of our eye to see things that are close or in a distance depends on a good accommodation. (Lang, 1995)
Accommodation does not only involve the lens because also a lens-less eye has the tendency to accommodate to near and far vision. (Rössler, 1941)
If due to motoric or sensory dysbalances the two eyes need to work harder to achieve a sharp image of the object that is viewed, asthenoptic complaints can occur. (Vranko, 2001)
The cause for this over-accommodation can be found in the eye itself (Hettrich, 2002; AKH-Consilium, 2006) but it can also be attributable to ascending or descending lesions of the spine and whole body. (Carreiro, 2004; Vranko, 2001)
In this context the atlas seems to play an important role for the movement of the eyes (Tricot, 1992). However, it can be said that an exclusive treatment of the upper cervical segments cannot change the vergence of the eyes. (Grifmann, 2003) In order to have a positive effect on the eyes with osteopathic treatment the main functional problem has to be treated within an overall osteopathic context. (Ham, 2004) The assumption that the eyes are linked with the whole body is an osteopathic doctrine which was evaluated by Pesendorfer (2002), who found out that the treatment of the eyes has a positive effect on the pain perception at specific trigger points as well as on the movement of peripheral joints.

The assumption that asthenoptic symptoms can be improved by osteopathic therapy thus seems worth to be examined further.

3 Hypothesis

Can osteopathic treatment improve asthenoptic complaints like impaired far-to-near accommodation, blurred vision, rapid fatigue, double vision, “dancing” letters, burning or watery eyes, headaches/migraine, dizziness, nausea, malpositioning of the head, squinting, winking, deteriorating vision, dyslexia or ADHD?

4 Background

This chapter will focus on the anatomical and physiological underpinnings of this work. In order to understand the interconnections in the human body a detailed knowledge of embryology, anatomy and physiology is necessary. In the context of this paper the background will focus on the function of vision.
It should be pointed out up front that particular attention was paid to choose references which provide scientifically sound information. Since the description of the interconnections of fissures, fascias and nerves are of interest mainly for osteopaths, I had to resort to osteopathic literature to serve as basis for these chapters, even though to a large extent it does not live up to scientific criteria. Nevertheless, the publications were written by renowned osteopaths, thus it should be no problem to use them as references.

4.1 Embryology

Already on day 25/26 the eye starts to develop from ectoderm in the region of the forebrain. At that time the neural tube is not closed yet. The eyes start to develop as grooves, also called optic sulci, which rapidly increase in depth. As vesicles they start to project from the lateral walls of the forebrain and grow laterally and towards the front, where they contact the telencephalic and diencephlic vesicles.
The lens placodes invaginate to form lens vesicles, which are cut off from the ectoderm and come to lie within the optic cup. Thus the forming lens is induced by the optic cup, the protein that is responsible for that is called Pax6.
The anterior lens epithelium proliferates rapidly through mitotic cell division, the posterior epithelium forms long cells which loose their ability to divide and become lens fibres. The anterior epithelium continues to form more fibres which are continuously relocated posteriorly. This means that the lens remains a purely cellular organ throughout life, without inclusions of connective tissue-like substances.
In the posterior section of the eye the inner layer of the optic cup develops into the retina, the outer layer forms the retinal pigment epithelium. In the anterior region of the eye this tissue forms the ciliary body, the iris and the M. dilatator pupillae.

The retina can be regarded as a projected part of the cerebral cortex and it develops also similarly, i.e. through migration of cells from a ventricular mitosis-rich matrix zone and through formation of layers.
The above mentioned optic sulcus also serves as orientation for the development of the optic nerve towards the diencephalon. Also vessels are situated in the foetal optic fissure, which penetrate into the optic cup and supply the lens (A. hyaloidea).
The outer margins of the optic cup (where the inner layer folds over to form the outer layer) delimit the pupil. The connective tissue envelop of the optic cup, a derivate of the neural crest, forms the stroma of the iris and the M. spincter pupillae anteriorly, a little further posteriorly it forms the ciliary body with the M. ciliaris and finally the choroid membrane
These soft tissues are covered by the outermost layers of the eye, the sclera and cornea, where the eye muscles are attached to, which do not develop from ectomesenchyme but from prechordal mesenchyme.
The eyelids start to form in the seventh week. They grow toward each other and adhere during the eighth week. They remain closed until the $7^{th}/8^{th}$ months. They are of mesodermal origin.
The optic chiasm is formed through axons of optic nerve ganglion cells that start to grow and progressively fill up the optic nerve, which runs to the floor of the diencephalon. At the chiasm half of the axons in each optic nerve cross the midline to enter the contralateral optic tract and continue to the posterior region of the thalamus (metathalamus). The optic tract ends in the Corpus geniculatum laterale, from where the cortical visual pathways start.
In the occipital lobe the visual inputs are processed, thus the occipital lobe differentiates further to take on this important role for the visual system.
To provide reflex connections a highly differentiated complex of nuclei develops in the tectum of the midbrain: the colliculi superiores of the lamina tecti. Today it is assumed that about 50 – 60 percent of the telencephalic cerebral cortex is concerned with the processing of stimuli of the visual system. (Rohen, 2004).

4.2 Anatomy

4.2.1 Bones

The bones of the orbit develop in membrane. According to Kazinczy (2003) these bones are subject to a continuous change and reorganization during the intrauterine development and

also after birth. In the early embryologic development the eye is oriented laterally and the optic nerve lies in a frontal plane. When the face starts to develop, the eyes move more medially and anteriorly, so that they are directed forward at the time of birth. Also the optic nerve changes its position, following the migration of the eyeball to finally adopt an oblique direction. (Rohen, 2004)

1: Canalis infraorbitalis
2: Canalis opticus
3: Crista lacrimalis anterior
4: Crista lacrimalis posterior
5: Fissura orbitalis inferior
6: Fissura orbitalis superior
7: Foramen infraorbitale
8: Foramen zygomaticofaciale
9: Foramina ethmoidalia anterius et posterius
10: Incisura frontalis
11: Maxilla
12: Os ethmoidale
13: Os ethmoidale, Lamina orbitalis
14: Os frontale
15: Os lacrimale
16: Os nasale
17: Os palatinum
18: Os palatinum, Proc. orbitalis
19: Os sphenoidale
20: Os sphenoidale, Ala major, Facies orbitalis
21: Os zygomaticum
22: Os zygomaticum, Facies orbitalis
23: Sulcus infraorbitalis
24: Sutura frontomaxillaris
25: (Sutura zygomaticofrontalis)
26: Sutura zygomaticomaxillaris

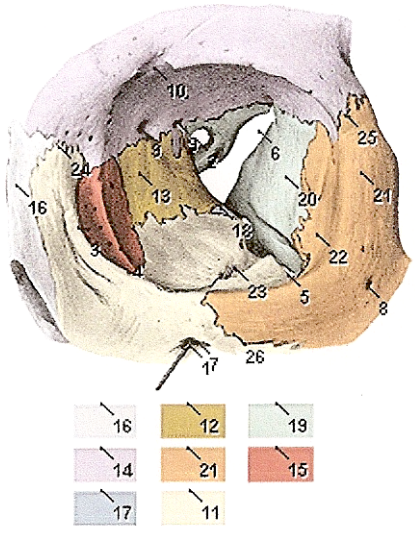


Figure 3

The bony orbit is formed by seven bones. Some belong to the cranial base, some to the cranial vault and face. Due to the large number of bones and sutures of the orbit, the eye socket has a great mobility and adaptability.

The bones that contribute to the orbit are: the frontal bone (Os frontale), sphenoid (Os sphenoidale), maxilla (Os maxillare), lacrimal bone (Os lacrimale), ethmoid (Os ethmoidale), zygoma (Os zygomaticum) and palatine bone (Os palatinum).

The roof of the orbit is formed by the orbital plate of the frontal bone and the lesser wing of the sphenoid. The medial wall is formed by the frontal process of the maxilla, the lacrimal bone, the orbital plate of the ethmoid, the body of the sphenoid and the lesser wing of the sphenoid. The lateral wall is formed by the zygoma, the zygomatic process and the greater wing of the sphenoid. The floor is formed by the orbital plate of the maxilla and the zygoma as well as the palatine bone. (Sobotta, 2002)

Genarally it is assumed that the apex of the orbit is pointed posteriorly medially. The optic canal is situated at its end between the two roots of the lesser wings of the sphenoid (Magoun 1976). However, inspections and measurements of the skulls of adults and children suggest that the apex is located rather in the inferior medial region of the superior orbital fissure (Carreiro, 2004).

4.2.2 Fascias

The content of the eye sockets is protected and supported by the surrounding fatty tissue and fascias. A fascial sleeve surrounds the optic nerve and accompanies it until the posterior wall of the eyeball where it expands to form the fascia of the back of the eyeball. Wherever it meets one of the extrinsic muscles of the eye, the muscle is enveloped by it. In the posterior region, where the straight muscles of the eye originate from a common tendineous ring, the fascia merges with this tendineous ring. Where the oblique muscles of the eye attach to the bony structure of the eye socket the fascia around the muscles merges with the periosteum. Thus the orbital fascia is continuous with the periosteum of the eye socket. Through the continuous arrangement of the fascias of the M. rectus superior with the M. levator palpebrae, and of the M. retus lateralis with the M. rectus medialis a supporting system is formed which limits the eye movements to a certain degree and guides them.

1: Glandula lacrimalis, Ductuli excretorii
2: Glandula lacrimalis, Pars orbitalis
3: Glandula lacrimalis, Pars palpebralis
4: Lig. palpebrale laterale
5: Lig. palpebrale mediale
6: Maxilla, Proc. frontalis
7: M. levator palpebrae superioris, Tendo
8: Os nasale
9: Os zygomaticum
10: (Raphe palpebralis lateralis)
11: Septum orbitale
12: Tarsus inferior
13: Tarsus superior

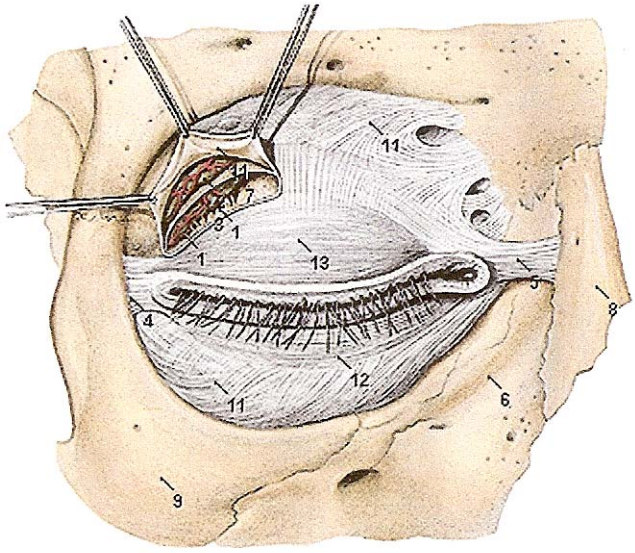
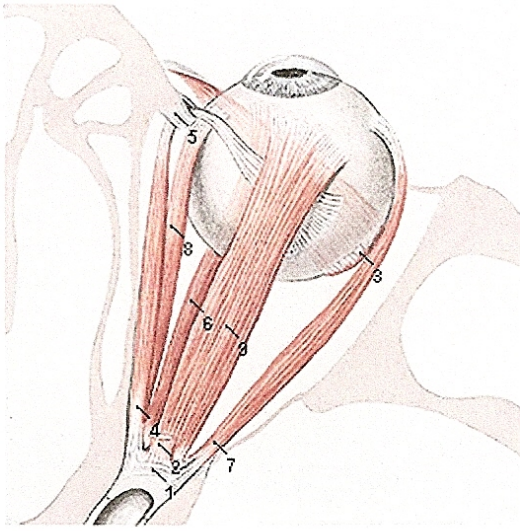


Figure 4

The influence of the fascial structures on the eye is important for conditions like astigmatism, disturbed refraction due to the form of the lens and presbyopia (loss of the accommodation ability of the lens). (Kahle, 2002; Sobotta, 2002)

4.2.3 Eye muscles

1: Anulus tendineus communis
2: M. levator palpebrae superioris
3: M. obliquus inferior
4: M. obliquus superior
5: M. obliquus superior, Trochlea
6: M. rectus inferior
7: M. rectus lateralis
8: M. rectus medialis
9: M. rectus superior



The M. levator palpebrae superioris originates from the roof in the region of the apex of the orbit above the M. rectus superior and the optic canal. The M. obliquus inferior originates at the maxilla in the region of the medial margin of the orbital floor. One portion of the M. obliquus superior originates at the sphenoid, medial to the optic canal. All other muscles of the eye have their origin at the common tendineous ring (Anulus tendineus communis). The M. levator palpebrae superioris attaches to the Trasus superior.

The four straight eye muscles (Mm. recti) attach anterior to the equator of the eyeball (equator bulbi occuli). The two oblique muscles (Mm. obliquii) have their attachment behind it. The M. obliquus superior runs through the loop of the trochlea, which is fixed at the superior medial angle of the frontal bone.

(Platzer, 2003; Sucker, 1997)

Figure 5

4.2.4 Nerves

The **optic nerves (N. opticus)** transmit information from the ganglia cells of the retina. These two nerves and the eyes as a whole are projections of the brain. They are covered by oligodentrocytes and not by Schwann cells. The optic nerves enter the cranial cavity through the optic canal. The two optic nerves unite in the optic chiasm, which is situated directly above the Sella turcica. The optic nerves within the orbit are a little bit longer than the distance between the eyeball and the optic foramen so that they are slightly curved. The optic nerves are enveloped by the three meningeal layers: pia mater, arachnoidea and dura mater. (Pöck, 1992; Morard, 1994; Kahle, 2002; Gray, 1989)

1: A. carotis interna, Pars cerebralis
2: Anulus tendineus communis
3: A. ophthalmica
4: Chiasma opticum
5: Corpus adiposum orbitae
6: Dura mater cranialis
7: Hypophysis
8: M. levator palpebrae superioris
9: M. rectus inferior
10: M. rectus lateralis
11: M. rectus superior
12: N. opticus [II], Pars canalis
13: N. opticus [II], Pars intracranialis
14: N. opticus [II], Pars orbitalis
15: Periorbita
16: Sinus cavernosus
17: Tractus opticus
18: Vagina externa
19: Vagina interna

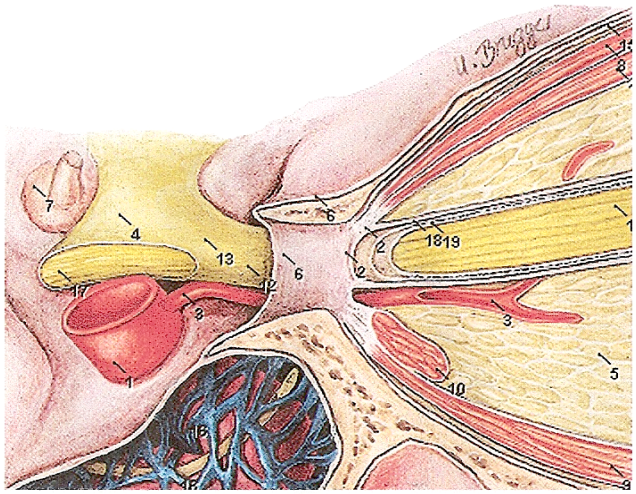
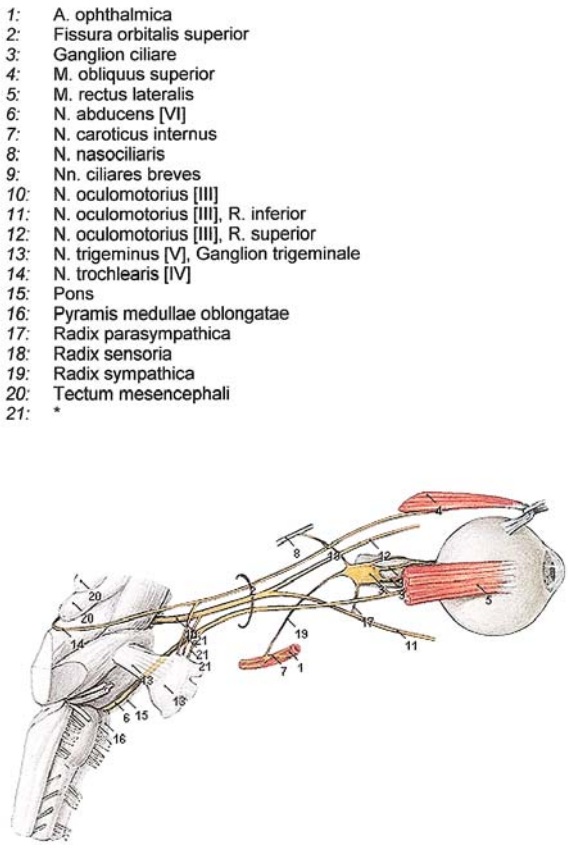


Figure 6

All muscles of the eye with the exception of the M. rectus lateralis und M. obliquus superior are supplied by the **oculomotor nerve (N. oculomotorius)**. It contains proprioceptive fibres from the trigeminal ganglion as well as motor and autonomous fibres from the cerebral nuclei. It follows a winding pathway towards the eyeball. It originates at the ventral aspect of the midbrain and runs through the subarachnoid space and is enveloped by a layer of pia mater. It runs between the A. cerebelli superior and the A. cerebri posterior, continues through the Cisterna interpeduncularis with the A. communicans posterior, penetrates the arachnoidea and continues between the loose and the fixed border of the tentorium cerebelli. In the vicinity of the posterior clinoid process (Proc. clinoideus posterior) it enters the dura mater and runs between its internal and external layer until the cavernous sinus (Sinus cavernousus) where it unites with sympathetic fibres of the internal carotid plexus (Plexus caroticus internus).

Finally, it reaches the orbit, where it divides into two branches: the superior branch (Ramus superior) runs laterally to the M. rectus superior and M. levator palpebrae. The inferior branch (Ramus inferior) supplies the M. rectus medialis and inferior as well as the M. obliquus inferior. The latter branch also sends fibres to the ciliary ganglion. Obviously the N. oculomotorius is susceptible to compression and irritation along its long and complicated pathway. The most critical sites are those where it runs across the borders of the tentorium and enters the dura mater because there increased tension can occur due to altered bony relationships or tight membranes. Any kind of irritation or compression of the tiny neural structures impairs the oxygen and nutrient supply of the nerve and thus can affect its conductibility. (Morard, 1994; Kahle, 2002; Magoun, 1976)



The **trochlear nerve (N. trochlearis)** innervates the M. obliquus superior and also follows an interesting pathway. Within the brainstem its fibres cross over to the contralateral side where they exit at the dorsal aspect. The nerve then runs anteriorly, winding around the brainstem and continuing between the A. cerebelli superior and A. cerebri posterior together with the N. oculomotorius. Directly underneath the free border of the tentorium cerebelli it penetrates the dura mater. It goes through the cavernous sinus accompanied by the N. oculomotorius and N. ophthalmicus.

Figure 7

It finally crosses the N. oculomotorius and enters into the orbit through the superior orbital fissure above the common tendineous ring. In the cavernous sinus the trochlear nerve integrates fibres of the trigeminal nerve (N. trigeminus). (Pöck, 1992; Morard, 1994; Kahle 2002)

The M. recuts lateralis is supplied by the **N. abducens**, which originates at the ventral region of the brainstem. It penetrates the internal dura mater and runs superiorly via the apex of the petrous portion of the temporal bone, passing underneath the Lig. sphenopetrosum. It goes through the cavernous sinus and enters the orbit via the common tendineous ring. There are two region where this nerve is in particular prone to mechanical irritation: on the one hand, in the region where it runs along the petrous portion (where an abnormal position can cause an increased traction on the nerve or the ligament can cause a compression of it), and on the other hand, at the site where it goes through the tendineous ring and can be influenced by the mechanics of the orbit, the form of the ligament or the position of the surrounding muscles and fascias. (Pöck, 1992; Morard, 1994; Kahle 2002)

4.3 Physiology of vision

The anatomy and physiology of the eye have not changed for thousands of years. The only things that have changed are the demands to our optic system.

"New technologies, computers, artificial light, traffic and television and the change in human life towards being more machine-oriented requires a new consideration of the organ of vision and a new look at eyesight as such."

(Bayer, 2006: 12)

The eye receives the incoming rays of light. Via the optic nerve the impulses are transmitted to the centre of vision, where they are processed. In order to produce a sharp image of its environment the eye has to adapt continuously to the surrounding and focus on the objects, persons or stimuli around it. This ability is called accommodation. (Lang, 1995)

The M. ciliaris which has its attachment anteriorly at the sclera in the vicinity of the canal of Schlemm, influences the tension of the zonular fibres. These fibres have a connection with the lens and are thus responsible for altering its refraction power. (Kahle, 2002)

1: Angulus iridocornealis
2: Camera anterior
3: Camera posterior
4: Cornea
5: Corpus ciliare
6: Facies anterior, Epithelium anterius
7: Facies posterior, Epithelium posterius
8: Fibrae zonulares
9: Iris
10: Iris, Facies anterior
11: Iris, Facies posterior
12: Lens
13: Margo pupillaris
14: M. ciliaris
15: M. sphincter pupillae
16: Ora serrata
17: Pars iridica retinae
18: Procc. ciliares
19: Reticulum trabeculare
20: Sclera
21: Sinus venosus sclerae*
22: Spatia zonularia
23: Stroma iridis
24: Substantia propria corneae
25: Zonula ciliaris**

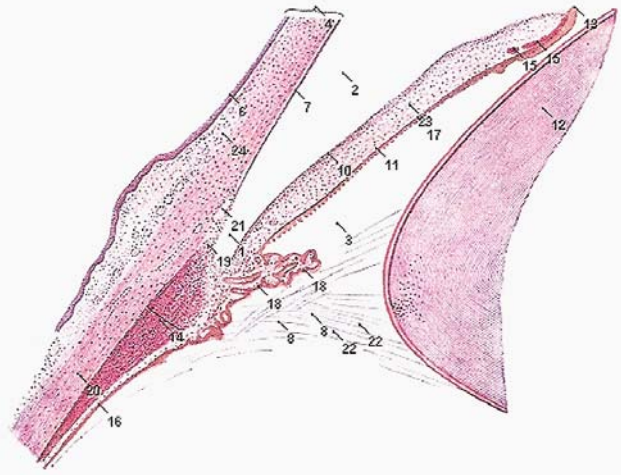


Figure 8

The ability to focus on objects at near (**near accommodation)** is controlled by the contracture of the parasympathetically innervated M. ciliaris (innervation: N. oculomotorius). This contraction entails the relaxation of the zonular fibres which consequently leads to a more rounded or spherical shape of the lens; its refraction power increases. At the same time the diameter of the pupil needs to decrease. This function is fulfilled by the M. sphincter pupillae, which is also parasympathetically supplied by the N. oculomotorius. (Waldeyer, 2003)

The focussing of objects in a distance (**far accommodation)** is achieved through a relaxation of the M. ciliaris; through an elastic membrane of the pupil the lens becomes more flat. The diameter of the pupil is increased by the sympathetically controlled M. dillatator pupillae. (Kahle, 2002)

The process of focussing is called **accommodation** and according to Hollwich (1988) it depends on an unimpaired innervation by the parasympathetic fibres of the N. oculomotorius and the elasticity of the lens.

4.4 Pathologies of vision

It has already been mentioned in the introduction that deterioration of eyesight (Hettrich, 2002) or dioptric asthenopia in the case of refraction errors (AKH-Consilium, 2006) are the reason for asthenoptic complaints. Thus the next chapters will explain the most common refraction problems.

4.4.1 Myopia

Myopia occurs if the eyeball is too long in relation to its refraction power. This means that the far point of a myope eye is situated in a finite distance **in front** of the retina so that the image is also formed in front of the retina and thus is not sharp.
This kind of ametropia cannot be compensated by accommodation because accommodation of the myope eye would produce a further anteriorization of the focal point on the side of the image.
(Vranko, 2001)

4.4.2 Hyperopie

Hyperopia can be observed if the eyeball is to short in relation to its refraction power. This means that the far point of a hyperope eye is situated in a finite distance **behind** the retina and thus again the image that is formed is not sharp.
Hyperopia can in part or even completely be compensated through accommodation, which increases the refraction power of the lens. However, hyperopia which is compensated through accommodation can cause asthenoptic complaints. Vranko (2001)

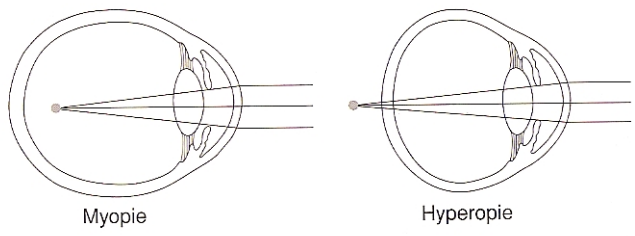


Figure 9

It is interesting that the aspect of differences in the length of the eyeball is very similar to the osteopathic theory of flexion-extension in primary respiration.

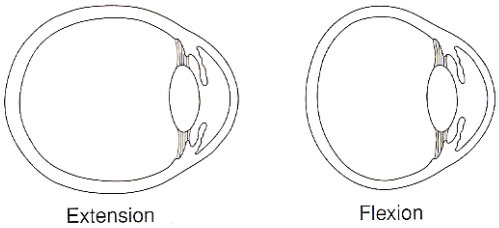


Figure 10

4.4.3 Anisometropia und Aniseikonia

Anisometropia is the condition in which the two eyes have unequal far point refraction. Anisometropia can be classified into: axial and refractive anisometropia. Axial anisometropia means that the two eyeballs differ in their length, but have the same refractive power.
In the case of refractive anisometropia the two eyes have different refractive powers but the eyeballs are equally long, which means that the size and form of the same object is perceived differently. This is called optic aniseikonia.
(Vranko, 2001)

"The different sizes make it more difficult to fuse the two images and thus binocular vision is impaired even to the extent of double vision. All of this can lead to asthenoptic complaints."

Vranko (2001:22)

4.4.4 Astigmatism

Astigmatism (irregular curvature of the cornea) is an optical defect producing a blurred image. Literally the term means "without point", which conveys that the rays from a source of light which go through the lens are not focused exactly on one point (focal point). (Vranko, 2001)

4.5 An attempt of a “different” explanation

A fact, which is often neglected by ophthalmologists and orthoptists, is that the refractive power of the eye changes depending on the time of the day and current activity.
This phenomenon cannot only be observed in adolescents and adults, who can influence their refractive power consciously but also in infants.

“During thirty years devoted to the study of refraction, I have found few people who could maintain perfect sight for more than a few minutes at a time, even under the most favorable conditions; and often I have seen the refraction change half a dozen times or more in a second, the variations ranging all the way from twenty diopters of myopia to normal.”

Bates (1999:57)

Bates states that the eyeball, which is controlled by the six extrinsic muscles, is subject to constant changes of shape and thus no refractive state, whether it is physiological or pathological, can be permanent. (Bates, 1999)

4.6 Models which establish a connection between the eye and the rest of the body

One osteopathic principle is that not (only) the symptom but the supposed cause of the symptom needs to be treated. (Becker, 2001)
In this context, it has to be pointed out, that this chapter is based mainly on osteopathic theories, whose scientific explanations are not soundly proven.

4.6.1 Connection between the eye and the muscular system

Regarding the embryologic development it is interesting that the musculoskeletal system develops from mesoderm just like the eyelid. This means that one could assume an "energetic" connection between the eyelid and the muscular system. (Liem, 2001)

It has already been pointed out in the introduction, that the brain always wants to "see straight". Among other things this is achieved through a delicate interaction of the upper cervical muscles, which work in a continuous action-reaction mode due to the vestibule-spinal and vestibule-ocular reflexes.
These reflexes cause balancing reactions and movements of the head when the direction of vision is changed, so that the whole body is involved in this action.
Carreiro (2004) writes that early-childhood scolioses can entail a misinformation of this system, because these reflexes are already developed at the time of birth.

4.6.2 Connection between the eye and the meninges

In the chapter 'Embryology' the eye is described as a projection of the brain and that it is enveloped by the three meningeal layers (dura mater, arachnoidea and pia mater). The outermost layer of the eye is called sclera, which represents a continuation of the dura mater and anteriorly merges into the cornea. Underneath are the arachnoidea, which is rich in vessels, and the pia mater. (Gray, 1989)

The optic nerve is also enveloped in the three meningeal layers. The most external layer is the dura mater, the middle layer is the arachnoidea and the innermost layer is the pia mater, which according to Gray (1989) has a continuous connection with the substance of the optic nerve.

The pyramid-shaped bony orbit originates in membrane. According to Magoun (1976) the ossification centres "swim" in the meninges and are held in place and protected by them. Also after birth the orbit is enveloped in these structures, thus tension can be transmitted to the eye via this connection. (Magoun, 1976)
The borders of the tentorium at the apex of the petrous portion of the temporal bone and their attachment to the posterior clinoid process play an important role because the oculomotor,

trochlear and abducens nerves pass in the vicinity of this site. The chapter ‘neurology’ already described how slight changes through traction or pressure of the meninges in this region can affect the function of theses nerves.

The meninges have a continuous connection with the spinal meninges, which have a firm attachment at the occiput, C2 and S2. This means that also dysbalances in the extremities and the pelvis can influence the eye and its function in a negative way. (Carreiro, 2004)

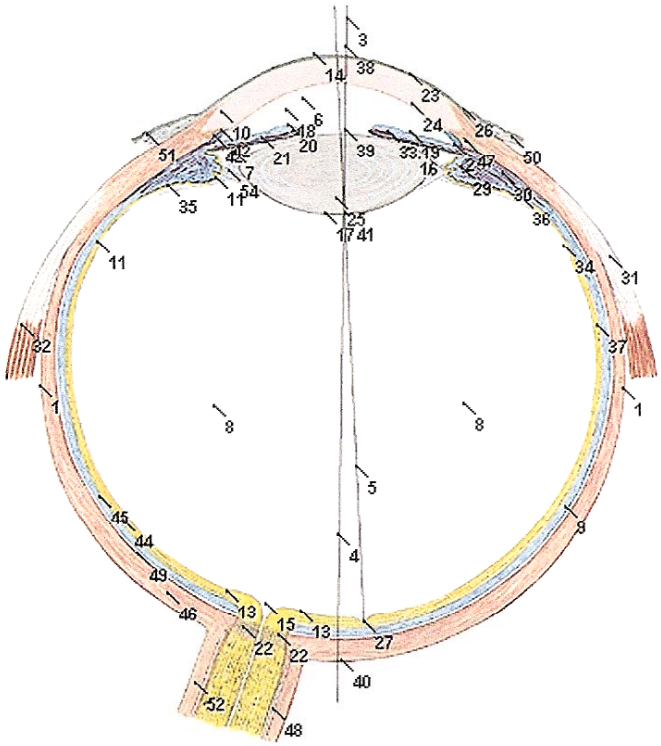


Figure 11

1: Aequator
2: Angulus iridocornealis
3: Axis externus bulbi
4: Axis internus bulbi
5: Axis opticus
6: Camera anterior bulbi
7: Camera posterior bulbi
8: Camera postrema [vitrea] bulbi
9: Choroidea
10: Cornea
11: Corpus ciliare
12: Corpus vitreum
13: Discus nervi optici
14: Epithelium anterius
15: Excavatio disci
16: Facies anterior (Lens)
17: Facies posterior (Lens)
18: Humor aquosus
19: Iris
20: Iris, Facies anterior
21: Iris, Facies posterior
22: Lamina cribrosa sclerae
23: Lamina limitans anterior*
24: Lamina limitans posterior**
25: Lens
26: Limbus corneae
27: Macula lutea, Fovea centralis
28: M. ciliaris
29: M. ciliaris, Fibrae circulares
30: M. ciliaris, Fibrae meridionales
31: M. rectus lateralis, Tendo
32: M. rectus medialis
33: M. sphincter pupillae
34: Ora serrata
35: Orbiculus ciliaris
36: Pars ciliaris retinae
37: Pars optica retinae
38: Polus anterior bulbi
39: Polus anterior lentis
40: Polus posterior bulbi
41: Polus posterior lentis
42: Reticulum trabeculare
43: Retina, Pars optica retinae
44: Retina, Pars optica retinae, Stratum nervosum
45: Retina, Pars optica retinae, Stratum pigmentosum
46: Sclera
47: Sinus venosus sclerae***
48: Spatium intervaginale subarachnoidale
49: Spatium perichoroideum
50: Tunica conjunctiva
51: Tunica conjunctiva bulbi
52: Vagina externa nervi optici
53: Vertex corneae
54: Zonula ciliaris

4.6.3 Connection between the eye and the fascias

One structure that plays a central role in osteopathic medicine has to be mentioned in particular: the sphenobasilar symphesis (SBS).
The SBS is formed between the basilar part of the occiput and the body of the sphenoid, which also forms part of the bony structure of the orbit.
All muscles of the eye (with the exception of the M. obliquus inferior) originate from this bone.
The Fascia centralis extends from the pelvic floor to the Tuberculum pharyngeum and represents a direct connection to the cranial base. In addition, the fascias of the neck and throat (Fascia cervicalis lamina superficialis, Fascia cervicalis lamina praetrachealis and praevertebralis) have a direct contact with the cranial base, can influence the cranial base and have thus also an influence on the ocular system. (Liem, 2001)

4.6.4 Connection between the eye and the nervous system

The sympathetic vegetative centres that are responsible for the eyes are situated between C7 and T3; they are referred to as Ganglion cervicale inferior or Ganglion stellatum.
These regions can be influenced viscerally via the lungs, oesophagus and upper abdominal organs or structurally via the first rib, muscles and fascias. It is also possible to have a vascular influence on this region via large arteries or veins. (Barall, 1988)
Also the vestibule-ocular reflex has to be mentioned again. Proprioceptive mechanorecepors, which are located in the cervical spine, have a permanent connection with the vestibular system and influence the muscle tone and posture.

The N. oculomotorius is connected with the trigeminal ganglion, which sends proprioceptive fibres into the cranial nerve III. Information on motor function and autonomous information are transmitted by the neural nuclei of the trigeminal nerve to the oculomotor nerve.
According to Sobotta (2002) the nerve also receives sympathetic fibres from the internal carotid plexus.
The inferior branch of the oculomotor nerve (Ramus inferior) which runs in the orbit sends fibres to the ciliary ganglion. (Sobotta, 2002; Morard, 1994; Kahle, 2002; Pöck, 1992)

1: A. carotis interna
2: A. ophthalmica
3: Bulbus oculi
4: Chiasma opticum
5: Colliculus superior
6: Corpus geniculatum laterale
7: Ganglion cervicale superius
8: Ganglion ciliare
9: Gemeinsames Gesichtsfeld
10: Gesichtsfeld des linken Auges
11: Gesichtsfeld des rechten Auges
12: N. oculomotorius [III]
13: N. opticus [II]
14: Radiatio optica
15: Sulcus calcarinus
16: Tractus opticus
17: *

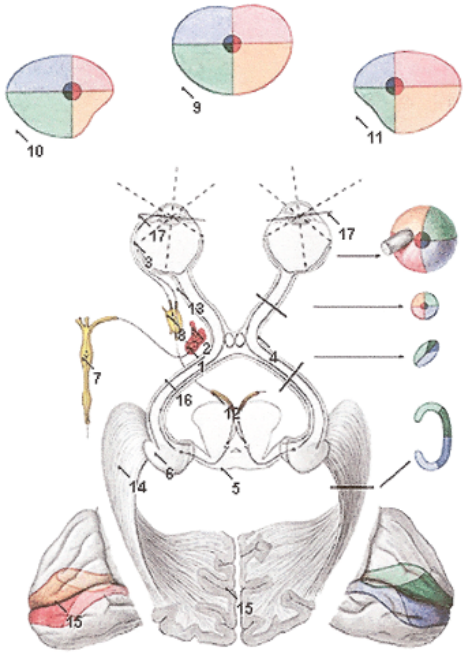


Figure 12

4.6.5 Vascular connections of the eye

4.6.5.1 Arterial supply

The eye disposes of two different vascular systems: the ciliary arteries and the A.centralis retianae. All vessels branch off the **A. ophthalmica**. The posterior **ciliary arteries** supply the uvea or Tunica vasculosa bulbi, which form the iris, the ciliary body and the choroidea of the posterior wall of the eyeball. Their vascular system is not only important for the blood supply but also for the maintanace of intraocular pressure and the tension of the eyeball.
About 1cm behind the eyeball the **A. centralis retinae** penetrates the optic nerve and runs inside the nerve to the Papilla nervi optici. Then it divides into several branches which run in the neural sheath layer at the internal surface of the retina. The vessels in the retina are end arteries. Their capillaries reach to the internal stratum granulosum. The venoles collect in the V. centralis retinae which follows the same pathway as the artery.

The supply of the photoreceptors is effected from both sides of the retina: the external supply is effected by the capillary system of the Aa. ciliares posteriores breves, while the internal supply is effected by the A. centralis. (Kahle, 2002)

4.6.5.2 Venous drainage

The cavernous sinus is situated at both sides of the sphenoid. It starts at the superior orbital fissure and extends to the apex of the petrous portion of the temporal bone. Anteriorly it has a connection with the superior ophthalmic vein (V. ophthalmica superior), posteriorly it drains into the petrous sinuses.

The superior petrous sinus drains the venous blood into the transverse sinus, from where it goes into the sigmoid sinus and finally into the internal jugular vein (V. jugolaris interna).

The inferior petrous sinus also starts at the cavernous sinus but drains directly into the internal jugular vein.

The intercavernous sinus also plays an important role in the drainage of venous blood. Via the basilar plexus, which is situated at the clivus, it has a connection with the venous plexus of the spinal canal.

Like in the cranium the spinal system of venous drainage is situted between the layers of the arachnoidea and dura mater. (Magoun, 1976; Sobotta, 2002)

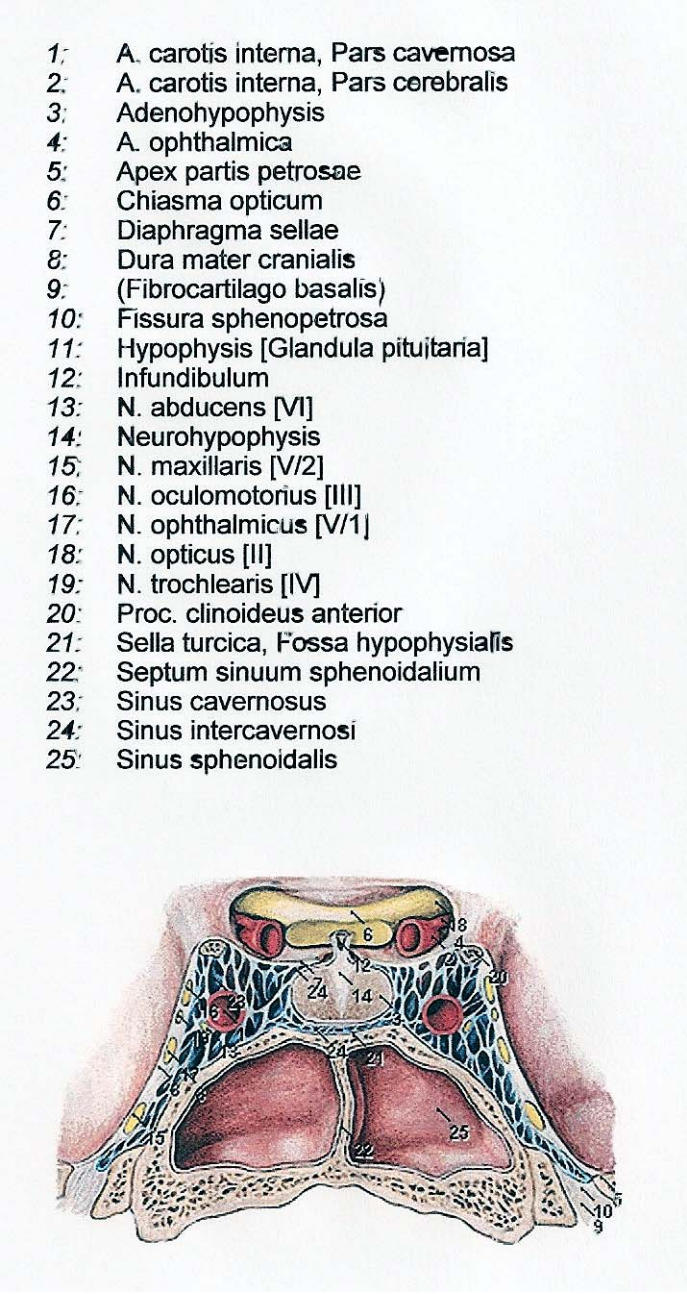


Figure 13

"The dura mater in the spinal canal is formed by the Lig. longitudinale posterior and the Ligg. flava. This means that the eye has a connection with the V. coccygealis and influences from all regions of the body can affect the eye and its function."

(Van de Heede, Personal communication, 2007)

5 Methodology

5.1 Study design

5.1.1 Study model

This experimental clinical study is organized as **pretest-postest control group design** and thus belongs to the group of **pragmatic randomized controlled studies**.

"This study design is relevant also for our research (osteopathic research). In this case an individualized treatment approach in the form of a black box or a package of care is evaluated. However, the effectiveness of one singular application within the package cannot be examined. The question in this form of study is thus more global, e.g. Is the individualized package of care 'osteopathy' effective?"

Peter Sommerfeld, Methodologie II, 2005 p. 22

A test – treatment – re-test design was deliberately not chosen because Grifman (2003) pointed out in her study that only one treatment with limited techniques might not achieve the desired therapy success.

The **ad hoc – sample** (not randomized sampling) which was carried out at the Hauptschule Timelkam (compulsory secondary school) comprised 280 test persons.

The test persons' age ranged between 10 and 15 years. Children of this age seemed particularly interesting to me because it is mainly this age group where visual problems usually manifest negatively (Carreiro 2004). In primary school asthenoptic problems often are compensated perfectly. (Vranko, 2001)

Out of the distributed 280 questionnaires 72 were returned.

5.1.2. Study group/control group

These 72 questionnaires were sorted manually and the evaluation showed that 40 met the inclusion criteria.
One test person dropped out so the overall sample consisted of 39 test persons.
An **ad-hoc sample** of 20 participants was **randomly** drawn from the overall sample of 39 participants.
Thus the overall number of participants was divided in a study group (20 test persons) and a control group (19 test persons).

Unfortunately, some participants had to be excluded from the statistical analysis because some did not or only partially complete the second questionnaire or did not go to the second ophthalmologic examination.

Thus the data of 14 test persons of the study group and 12 test persons of the control group were available for analysis.

Only test persons who completely met the inclusion criteria were included in the study.

5.1.3 The questionnaire – A description of asthenoptic symptoms

The questionnaire used in this study was developed by Schroth (2003) to evaluate whether visual problems were present in a patient. It is expressively stated that the questionnaire can be passed on free of charge.

In an accompanying letter Schroth addresses the issue of how difficult it is to recognize and understand functional problems of the eyes and he underlines how important the subjective perception by the child and also the parents or therapist is.

His questionnaire consists of 27 questions, 14 questions to be answered by the parents, 13 by the child. All 14 questions to the parents as well as 11 questions to the child can be answered on a scale of five. 2 questions to the child have different possible answers. The two questions are mentioned below:

Question 1: Do you read in your free time?
Answer 1: voluntarily and often
Answer 2: books
Answer 3: usually comics
Answer 4: I don't like reading

Question 2: If you read in your free time, how many minutes do you usually spend reading?
Answer 1: more that 30 minutes
Answer 2: up to 30 minutes
Answer 3: up to 10 minutes

Concerning the analysis of the answers Schroth states:

"If more questions are answered with the figures 3, 4 or even 5, than you can be sure that your child has to work more when reading than other children."

Schroth (2001:1)

The questionnaire was developed by Schroth to recognize functional eye problems. Thus it is a good basis for this master thesis. Except for two changes it has been adopted completely.

The two changes were:

1. In the first part which has to be answered by the parents question 4 reads: "Rubbing eyes, blinking or frowning often?" and question 12 wants to know about: "Rubbing eyes or squinting?"
   Both questions are almost identical and concern physical symptoms which are caused by an overstraining of the eyes.
   Thus question 12 was eliminated.

2. In the second part which has to be answered by the child the first question is: “Do you read in your free time?“ The answers to this question have already been mentioned above. I have decided to simplify this question because the choice of answers did not help me to draw any conclusions.
   For me the only relevant information from this question is whether the child is willing to strain his/her eyes also in his/her free time. Thus I have decided to only provide two possible answers: yes or no.

The questionnaire used for this thesis is thus identical with the one developed by Schroth as regards its content with the exception that the parents have to answer 13 instead of 14 questions and that the children cannot choose from 4 but only 2 possible answers to question 1.

5.1.3.1 Categories of the questionnaire

To evaluate the changes in the subjective perception of the complaints by the parents and children, the questions of the questionnaire were summarized in categories.
The categories and the associated questions are listed in tables 2 and 3.

Questions to the parents:

Category	Questions
Reading	Hesitating, letter-by-letter reading? Often looses the line when reading? Strange position of the head when reading? Can read large print better than small print?
Writing	Looses the lines when writing? Irregular handwriting when writing longer? Often draws over lines when colouring pictures? Mistakes when transcribing a text?
Gross motor skills	Difficulties catching balls, playing badminton or similar games? Stumbles over or bumps often against things?
Fine motor skills	Often draws over lines when colouring pictures? Does not like to do handicrafts, puzzle or use scissors?
Concentration	Impaired concentration ability? Mistakes when transcribing a text?
Observable physical overstaining symptoms	Strange position of the head when reading? Rubs his/her eyes often, frequent blinking or frowning?

Table 2

Questions to the children:

Category	Questions
Reading	Does reading become harder the longer you read? Is the print not sharp or blurred? Do the letters Move or 'dance'? Does the print seem double temporarily? Do you have difficulties reading what is on the blackboard? Is it difficult to look at your books and then on the blackboard? Is it difficult to look at the blackboard and then in your books?
Concentration	Does reading become harder the longer you read? Is the print not sharp or blurred? Do you have difficulties reading what is on the blackboard? Is it difficult to look at your books and then on the blackboard? Is it difficult to look at the blackboard and then in your books?
Observable physical overstraining symptoms	Do you have burning or watery eyes when reading? Do your eyes get tired from watching television or playing video games? Are you sensitive to bright light? Do you suffer from headaches?

Table 3

5.2 Inclusion and exclusion criteria

5.2.1 Inclusion criteria

This study includes only those test persons who returned a positive questionnaire on the subjective problems of asthenopia.
The questionnaire is regarded as positive if the answer '5' is chosen once or several times, '4' is selected three or more times and '3' is marked six or more times as answer.
This follows the recommendation of Schroth (2001) who writes in his information sheet that in his opinion visual problems are only present if the questions are answered several times with 3, 4 or even 5. Since the expression "several times" is quite broad I have decided to follow the above mentioned procedure.

5.2.2. Exclusion criteria

Patients with pathological eye conditions were excluded, but none of the test persons suffered from a pathology.

5.3 Outcome measures and measuring instruments

5.3.1 Primary outcome measure

The **questionnaire** to identify asthenoptic complaints served as primary outcome measure. Since the diagnosis asthenopia represents only a description of symptoms this approach seemed only logical to me.

5.3.2 Secondary outcome measure

The ophthalmologic examination and the resulting data were determined as secondary outcome measure.

5.3.3 Measuring instruments

Basically, the measuring tools used in this study can be divided into two categories:

3. Questionnaire (evaluation of the subjective perception)
4. Ophthalmologic measuring instruments and tools for diagnosis (valid data)
    a. Visus examination (measurement of visual acuity without refraction)
    b. Sciascopy (measurement of visual acuity with refraction)
    c. Measurement of accommodation
    d. Lang stereo-test (test of strabismus)
    e. Funduscopy (examination of the back part of the eye’s interior to exclude pathologies)

5.4 Implementation of the study

5.4.1 Recruitment

After obtaining the necessary permission of the provincial education authority Mr Eitzinger and headmaster Ms. Bernardi I presented the contents of my thesis and the planned study design during a parent-teacher meeting.
At this occasion the parents were informed about possible risks and the current situation with regard to data protection. Before the start of the treatment program a written declaration of consent (cf. annex) had to be signed.
In addition, the parents were asked to abstain from any ophthalmologic or orthoptic intervention during the 7 weeks scheduled for the study, but only as long as the child would not suffer any harm through this. Further, they were informed that any kind of surgical or dental intervention as well as the administration of antibiotics – to mention only the most important things – could influence the outcome of the study and thus it would be preferable to avoid anything like that if possible.
In how far the parents observed all these things during the study period I cannot check nor judge from my perspective. Thus it is absolutely possible that the results were influenced by external factors.

5.4.2 Procedure and time frame

After the random division into study group and control group the following procedure was observed:

<table>
<tr><th>Study group</th><th>Control group</th></tr>
<tr><td>Ophthalmologic examination</td><td>Ophthalmologic examination</td></tr>
<tr><td>After 1 week
Treatment I</td><td rowspan="3">No intervention</td></tr>
<tr><td>After 2 weeks
Treatment II</td></tr>
<tr><td>After 3 weeks
Treatment III</td></tr>
<tr><td>After 7 weeks
Ophthalmologic examination
+
Completion of questionnaire</td><td>After 7 weeks
Ophthalmologic examination
+
Completion of questionnaire</td></tr>
</table>

Table 4

The test persons were treated in the school building during regular class time. The treatment took place in a special room provided for this purpose and adapted for 2 practitioners carrying out osteopathic treatments.
In order to guarantee a better comparability with the ophthalmologic data we paid attention to the time and day of treatment, so that the ophthalmologic examination was carried out on the same day and time.

5.4.3 Examination

5.4.3.1 Case history

Before the first osteopathic treatment a case history sheet was given to the parents, which contained questions about the current pain situation, chronic diseases, traumas, operations, scars, organic problems, medication, allergies, vegetative symptoms like headaches or dizziness and possible orthodontist interventions or braces.
In addition, the parents provided written information on previous therapeutic interventions and possible complications during pregnancy, the birth process or the child's development during his/her first year of life.

5.4.3.2 Osteopathic examination

During the first treatment session a thorough osteopathic examination of the patient was carried out without following a set order.
Particular attention was paid to the mobility of the eyes, the cranium and its involuntary mechanism, the connection between occiput, atlas and axis, the cervicodorsal junction and the upper thoracic inlet.
Nevertheless, the practitioner was free to choose which techniques to apply and where in the body.
The most important objective was to find and correct the somatic dysfunction(s) since negative influences on the eyes can originate anywhere in the body as described in the chapter on anatomy.

The following is a rough outline of the proposed examination procedure (cf. Annex):

1. Observation
2. Active/passive mobility tests
3. Clinical tests (to identify possible contraindications)
4. Special structural, visceral and craniosacral osteopathic tests
5. Inhibition (to find the greatest somatic dysfunction)
6. Specific tests of the eyes:
    a. Observation (e.g. size of the pupil)
    b. Evaluation of the intraocular pressure (through careful compression)
    c. Active mobility in cranial, caudal, medial and lateral direction
    d. Passive mobility in cranial, caudal, medial and lateral direction

5.4.4 Description of intervention

Since a visual dysfunction often goes hand in hand with a dysfunction of the upper cervical and dorsal segments (Tricot 1992, Gorman 1995, Grifman 2003, Carreiro 2004, Magoun 1976, Liem 2001) direct techniques on these vertebral segments represented a large portion of the treatment. Jones and Mitchell techniques were applied as well as structural articulation and soft tissue techniques.

In addition, craniosacral treatments according to Sutherland (Sutherland 1976) and techniques that were tought by Hanneke Nusselein and Jean Arlot during osteopathic training were used.

In cases were a visceral intervention was necessary the patients were treated with techniques according to J.-B. Barral (1988) and techniques tought by Bernard Ligner.

In short, the whole range of osteopathy was packed in a “black box” and applied in practice – as described by Perter Sommerfeld (2005).

At the beginning of the first treatment the practitioner discussed everything with the test person and his/her parents (if present), the data from the case history sheet was considered and a thorough osteopathic examination and analysis of the findings was carried out. Such an

analysis was again carried out at the beginning of each subsequent treatment session to be able to recognize and record possible changes and to adapt the treatment plan to the new conditions.

6 Statistics

To guarantee transparency of the results this chapter will describe the statistical analysis of the data obtained through the instruments presented in the chapter ‘Methodology’ and through the examination of the participants in the study group and the control group.

6.1 Statistical analysis

The statistical analysis of the data obtained by means of the questionnaire from the parents and children was carried out in three steps. First, the answers to the closed questions were entered in a computer file for further processing. Second, the answers were summarized in certain categories depending on their content. Third, the results were interpreted.

The statistical analysis was carried out by means of the program Microsoft Excel (version 2000). The data were entered manually by the author before their plausibility was evaluated with the program SPSS 11.0. Minor errors could be detected and were corrected.

The descriptive results were calculated and the following illustration methods will be used to display the results:

- Frequency tables
- Contingency tables

The descriptive results are presented in percent and mean values.

The following methods are used to carry out comparisons and examine interconnections between answers to different questions, and in particular to evaluate the original hypothesis:

- Contingency tables:
  - Chi squared test (to evaluate the probability distribution of two variables; e.g. age and the category reading)
  - Pearson tests were used to measure correlation.

- T test
  - To evaluate whether the mean values of two samples (study group and control group) differ in a quantitative characteristic (e.g. the category reading)
  - The Levene test looks at the equality of variances. All calculations were carried out with a confidence interval of 95 percent.

It can already be pointed out that none of the calculations provided significant results. This is definitely due to the small number of test persons. But carefully formulated some tendencies can be observed nevertheless. These tendencies could maybe be confirmed if the study was carried out with a larger sample population, which could provide significant results.

6.2 Presentation of the results

After a brief description of the most important demographic characteristics of the study group and the control group the following chapters will present the categories described in the methodology. The categories reading, concentration and observable physical overstraining symptoms will be described in detail, in particular because the data of these categories was collected from both the parents and the children. The results of the categories writing, gross and fine motor skills will be summarized because they are merely based on the observations of the parents.

The results will be presented separately for the study group and the control group.

It has already been mentioned that the study group comprised 14 participants, while the control group consisted of 12 participants. Chapter 5.4.4 described the treatment which the participants of the study group received. The control group was not treated with any kind of osteopathic intervention. Both groups, however, were re-examined in a post-test.
The data were evaluated but it has already been pointed out earlier that the analysis did not provide any statistically significant results. Nevertheless, some tendencies could be observed. If required, references are made to the study of Gorzny (2005).
After the evaluation of the hypothesis the results of the medical examinations are summarized.

6.3 Evaluation of the hypothesis

It has already been mentioned in the chapters 1-4 that it seemed to be interesting to evaluate the hypothesis **“Osteopathic treatment can improve asthenoptic complaints”.**

On the basis of diagnosed myopia, emmopia or hyperopia and taking into account accommodation I wanted to find out whether various aspects like reading, writing, gross and fine motor skills, concentration and observable physical complaints can be subjectively improved through osteopathic treatment.

As mentioned in chapter 2 the underpinnings for this work are provided by the study of Gorzny (2005) and the questionnaire he used.

To facilitate a comparison of the results the subjective rating of both the study group and the control group before and after the osteopathic intervention will be presented in the analysis.

Below the question of the study is mentioned once more and the table illustrates the two groups and the overall number of participants.

Question: Can osteopathic treatment improve asthenoptic complaints?

Study group	Control group	n - Total
n = 14	n = 12	26

Table 5

6.3.1 Demographic description of the study group and the control group

The study group comprises a total number of 14 children, 7 girls and 7 boys, aged between 11 and 14 years. The control group included a total of 12 children, 3 girls and 9 boys. Their age ranged between 11 and 14 years.

Overall 10 girls and 16 boys participate in the study. This means that the overall sample consist of 61.54 % male and 38.46 % female participants. This is interesting in particular in comparison with the study of Gorzny (2005), who observed a similar gender distribution with a total sample of 118 participants.

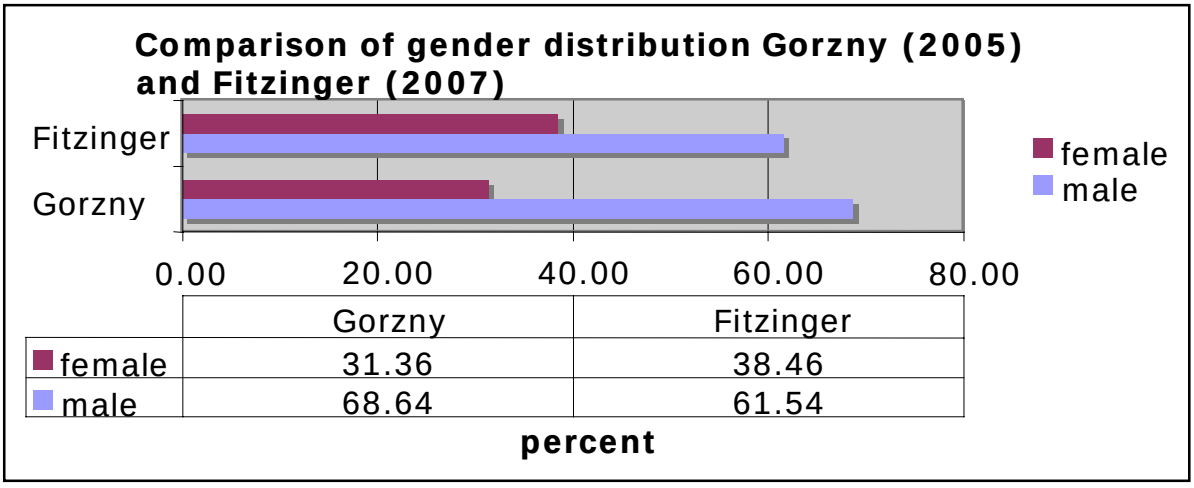


Diagram 1

Whether this can lead to the conclusion that boys are more frequently affected by asthenopia could be verified by means of other comparable studies or physicians' records.

6.3.2 Reading

6.3.2.1 Study group

Before the start of the osteopathic interventions the parents indicated that they could observe reading problems in about a third of the participating children.
These problems could be reduced by almost 13 percent as illustrated by the post-test results (after the intervention). Thus an improvement could be observed even though the result is statistically not significant.
Table 6 below presents the observed problems in percent:

Parents	Pre-test	Post-test	Difference
Reading	33.48 %	20.54 %	- 12.95 %

Table 6

The children themselves consider their reading problems slightly better than the parents before the treatment but after the intervention they are a little bit more careful in rating the improvement. According to the children's estimates their reading problems only improved by about 8 per cent.
The results are presented in table 7 below:

Children	Pre-test	Post-test	Difference
Reading	33.25 %	25.51 %	-7.74 %

Table 7

6.3.2.2 Control group

Also in the control group the parents of the participating children observed reading problems in almost a third of the children.
After the end of the study period these problems were only reduced by about 4 percent. Thus a slight improvement could be observed.
Table 8 presents the exact figures:

Parents	Pre-test	Post-test	Difference
Reading	32.29 %	28.13 %	- 4.16 %

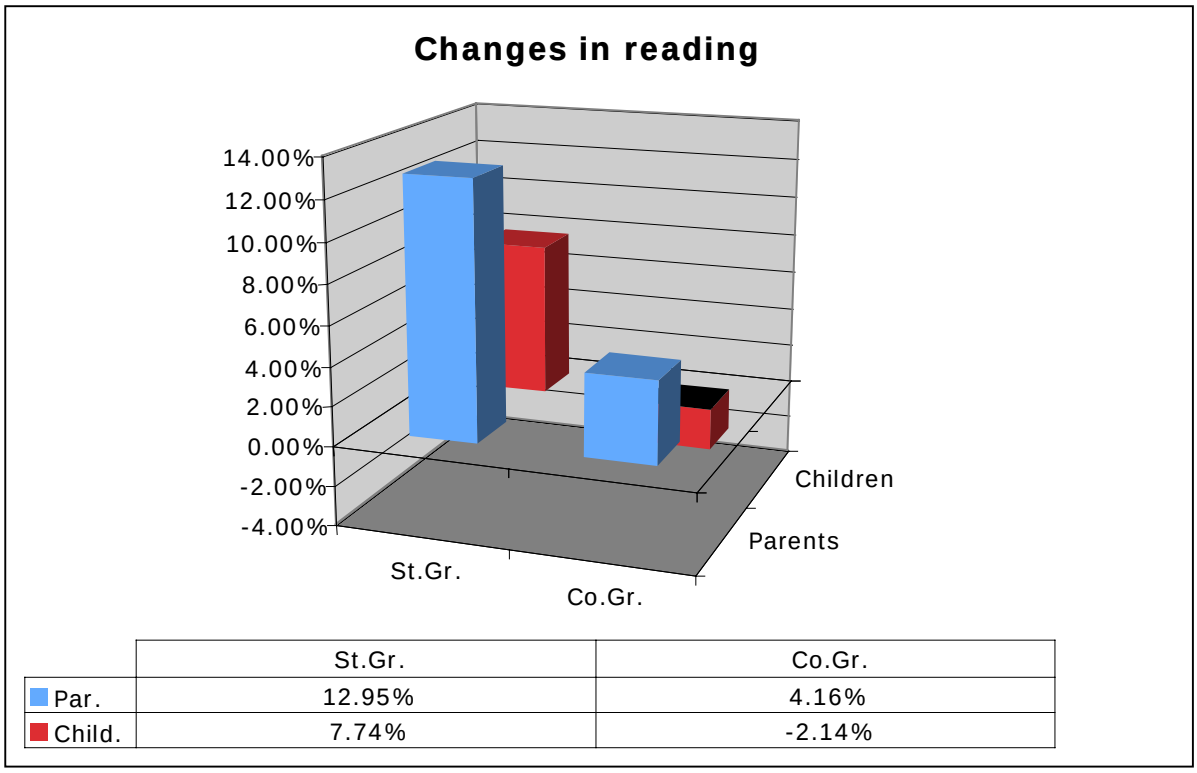
Table 8

Also in the control group the children considered their reading abilities slightly better than their parents. A difference with the study group can be observed in the results at the end of the study period, where the children of the control group indicated a slight deterioration.

Children	Pre-test	Post-test	Difference
Reading	29.46 %	31.60 %	2.14 %

Table 9

6.3.2.3 Summary



	St.Gr.	Co.Gr.
Par.	12.95%	4.16%
Child.	7.74%	-2.14%

Diagram 2

In both groups the parents observed an improvement in the category reading at the end of the study period. In the study group the improvement was 9 percent greater than in the control group. With this sample size the difference was statistically not significant but maybe a slightly altered study design and a larger sample could provide significant results. However, the present results could indicate a tendency.
The children of the study group noticed an improvement after the treatment, while the children in the control group thought their reading problems were slightly worse.

Thus the observations of the parents do not differ regarding the category reading and the reading problems of their children. On the basis of the collected data it can be assumed that in general the children rate their reading abilities slightly better than the parents.
The post-test results are quite interesting, because after the study period the children are more careful in rating their reading problems than the parents.

In addition, the leisure time reading behaviour of the children was examined in this category, which under these circumstances also speaks in favour of the children in the study group. Even though the children consider their reading problems more carefully than the parents, the following diagram illustrates that the reading behaviour of the children, who received an osteopathic treatment, changed considerably, i.e. they are reading more.

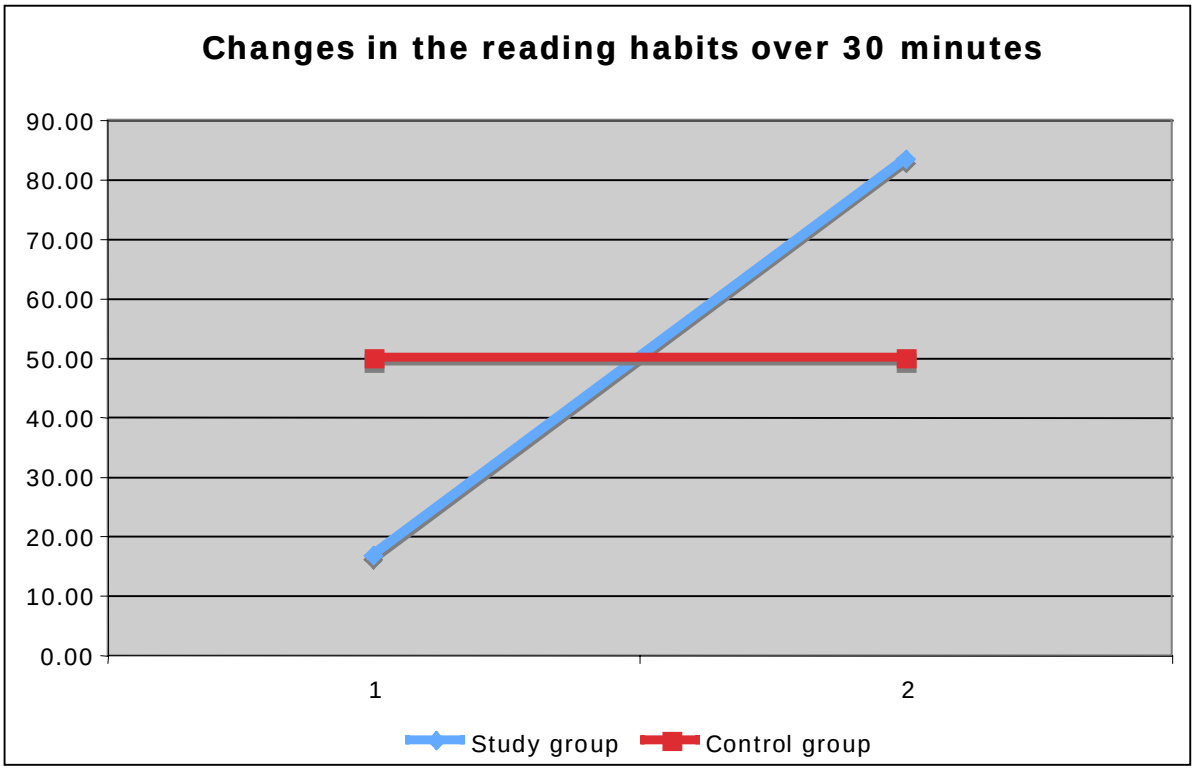


Diagram 3

This is another tendency that could be observed and it probably would be interesting to study it more closely.

For the category reading it can be pointed out in general that changes could be observed in both the study group and the control group, with the more positive changes occurring in the group that received osteopathic treatment, which would speak in favour of this kind of treatment. However, it has already been emphasized several times that these results have to be regarded with the reservation that with this sample size they were statistically not significant.

6.3.3 Concentration

6.3.3.1 Study group

Before the beginning of the osteopathic interventions the parents indicated problems of concentration in almost two thirds of the children.
According to the parents' observations these problems could be reduced by about 16 percent after the intervention. Thus an improvement could be achieved. Again, the result was statistically not significant, but it could represent a tendency, which could be of significance in studies of a larger scale. Since this category showed the greatest change in percent, the result of the t-test will be presented as well in order to illustrate the lacking significance. To demonstrate significance the calculated value should be smaller than 0.05, but the calculated figure was 0.08.
Table 10 below summarizes the results:

Parents	**Pre-test**	**Post-test**	**Difference**
Concentration	64.29 %	48.21 %	- 16.08 %

Table 10

In this category the children consider their concentration abilities much better than the parents before the intervention. In the post-test they also indicate that they have the feeling their concentration has changed positively. Again the children are more careful when it comes to the degree of improvement as can be seen in table 11 below:

Children	**Pre-test**	**Post-test**	**Difference**
Concentration	36.25 %	26.43 %	- 9.82 %

Table 11

6.3.3.2 Control group

The parents in the control group also observed an improvement of the concentration of their children by about 5 percent.

Parents	Pre-test	Post-test	Difference
Concentration	50.00 %	44.79 %	- 5.21 %

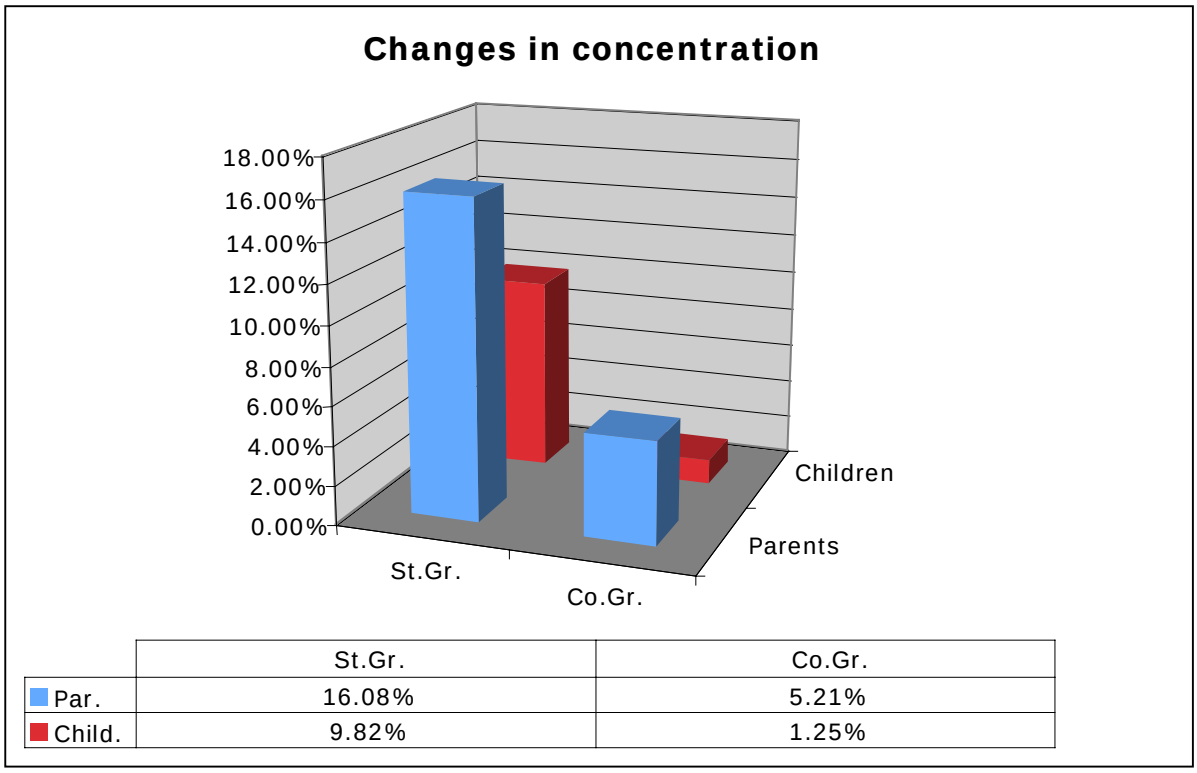
Table 12

Table 13 shows that also the children of the control group did notice a slight improvement of their concentration:

Children	Pre-test	Post-test	Difference
Concentration	34.17 %	32.92 %	- 1.25 %

Table 13

6.3.3.3 Summary



	St.Gr.	Co.Gr.
Par.	16.08%	5.21%
Child.	9.82%	1.25%

Diagram 4

The parents and children of both groups noticed positive changes in concentration at the end of the study period.

Again the tendency could be observed that for both the parents and the children of the study group the changes were subjectively greater and more positive than in the control group. Like in the category ‘Reading’ this tendency could speak in favour of the osteopathic interventions.

6.3.4 Observable physical overstraining symptoms

6.3.4.1 Study group

At baseline the parents indicated that they could notice weaknesses in the category "observable physical overstraining symptoms" in about a quarter of the children. According to the parents' impression these weaknesses were reduced by about 4 percent after the intervention. Thus an improvement could be observed, even though it was statistically not significant.
The calculated values are presented in table 14:

Parents	Pre-test	Post-test	Difference
Overstraining	25.89 %	21.43 %	- 4.46 %

Table 14

The children themselves had a clearly worse impression of their physical overstraining symptoms than their parents at the beginning of the study. But also after the intervention they noticed an improvement of almost 9 percent.
Table 15 illustrates the results:

Children	Pre-test	Post-test	Difference
Overstraining	48.81 %	40.18 %	- 8.63 %

Table 15

6.3.4.2 Control group

At the end of the study period the parents of the control group noticed a slight deterioration of the physical overstraining symptoms of their children. Table 16 illustrates this tendency:

Parents	Pre-test	Post-test	Difference
Overstraining	25.00 %	26.04 %	1.04 %

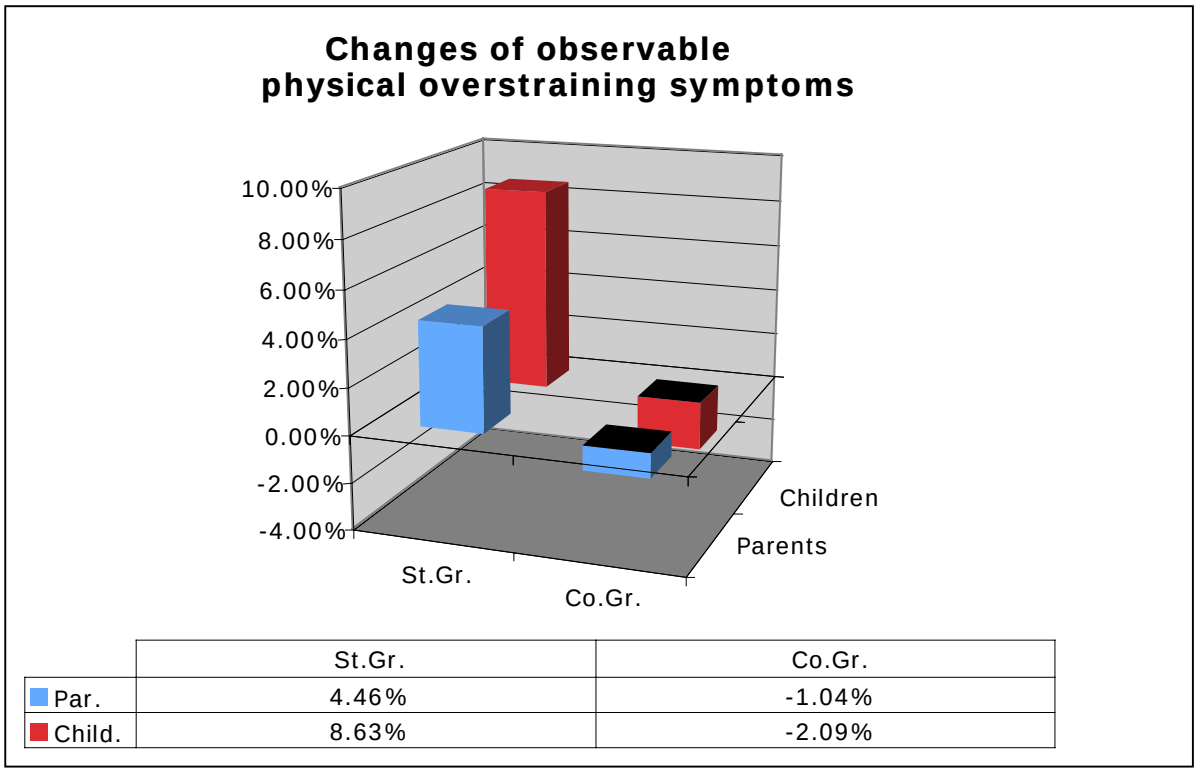
Table 16

At the beginning of the study the children of the control group considered their observable physical overstraining symptoms clearly worse than their parents. But regarding the difference observed after the study period they are almost in line with the impression of their parents since they indicated a deterioration of about 2 percent in the post-test.
The results for this category are summarized in table 17:

Children	Pre-test	Post-test	Difference
Overstraining	39.58 %	41.67 %	2.09 %

Table 17

6.3.4.3 Summary



	St.Gr.	Co.Gr.
Par.	4.46%	-1.04%
Child.	8.63%	-2.09%

Diagram 5

The results in the category ‘observable physical overstraining symptoms’ show an improvement in the study group, while a deterioration could be observed in the control group. Again this tendency could speak in favour of osteopathic interventions.
This was the first category where all the children considered their symptoms worse than their parents.

6.3.5 Writing, gross and fine motor skills

For these three categories only the data obtained from the parents was available for analysis.

6.3.5.1 Study group

Before the start of the osteopathic interventions the parents indicated that they observed considerable weaknesses in the categories writing, gross and fine motor skills. All problems could be reduced, in particular the writing skills of the children improved by about 12 percent. Table 18 lists the calculated values:

Parents	Pre-test	Post-test	Difference
Writing	43.15 %	30.80 %	- 12.35 %
Gross motor skills	26.79 %	15.18 %	- 11.61 %
Fine motor skills	29.46 %	25.89 %	- 3.75 %

Table 18

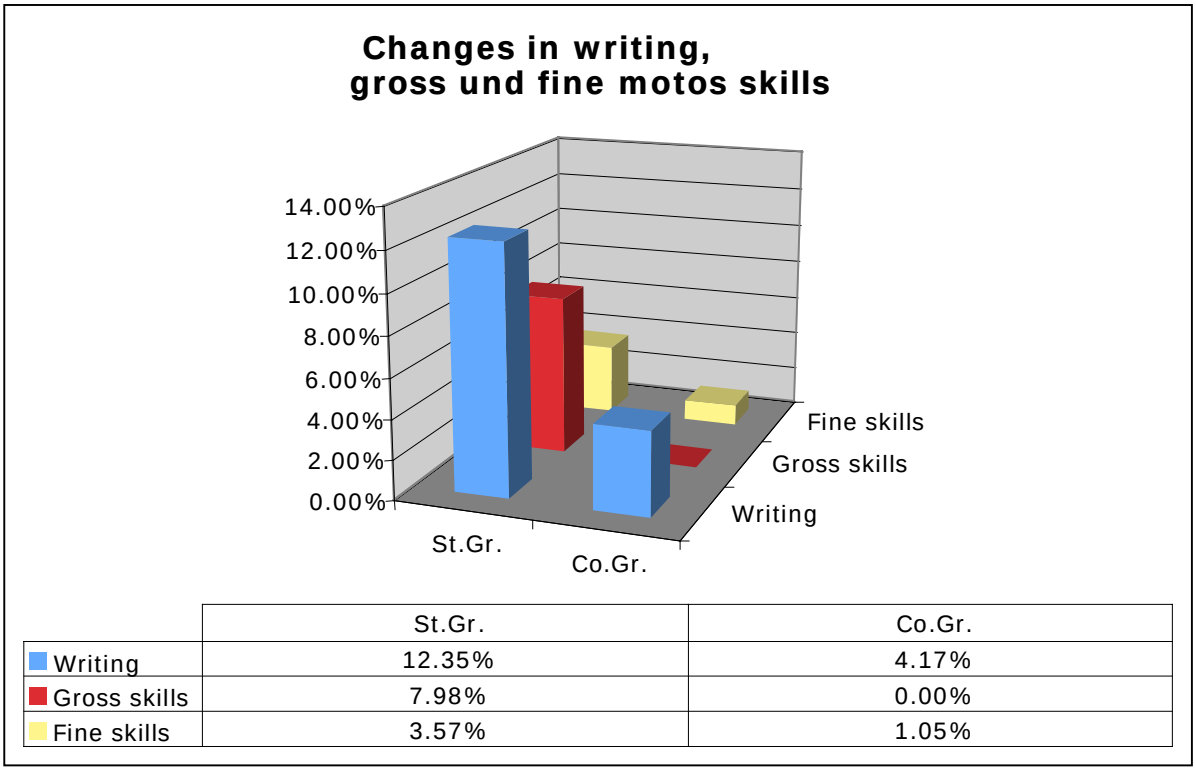
6.3.5.2 Control group

At the end of the study period also the parents of the control group could notice improvements of their children in the categories writing and fine motor skills, while the category gross motor skills did not change. The degree of observed improvement is clearly smaller than in the study group.
The results are presented in table 19:

Parents	Pre-test	Post-test	Difference
Writing	47.40 %	43.23 %	- 4.17 %
Gross motor skills	18.75 %	18.75 %	0 %
Fine motor skills	40.63 %	39.58 %	- 1.05 %

Table 19

6.3.5.3 Summary



	St.Gr.	Co.Gr.
Writing	12.35%	4.17%
Gross skills	7.98%	0.00%
Fine skills	3.57%	1.05%

Diagramm 6

The parents of both groups noticed positive changes in the categories writing and fine motor skills at the end of the study period.

In the study group also the gross motor skills improved, while they remained unchanged in the control group.

Another tendency can be observed: the parents of the study group identified much greater and more positive changes than the parents of the control group.

This observed tendency could again speak in favour of the osteopathic treatment method.

For a better description and interpretation of the results in the categories reading, writing, gross and fine motor skills as well as concentration and observable physical overstraining symptoms the ophthalmologic findings before and after the study period will be presented in the next section.

6.3.6 Ophthalmologic examination

A comparison of the measurements of the children's myopia, emmopia and hyperopia in the course of ophthalmologic examinations before and after the osteopathic intervention showed no statistically significant differences between the study group and the control group. As regards accommodation the tendency of a slight improvement might be identifiable, which again could speak in favour of osteopathic treatment.

The results of the measurements are presented in table 20 below:

Comparison of the changes in myopia, emmopia and hyperopia

	Study group	Control group	Changes in dpt
Ref. right eye, patients with 0 dpt	-0.33	-0.38	0.05
Refraction right eye, patients with myopia (-)	1.25	-0.08	1.33
Refraction right eye, patients with hyperopia (+)	0.08	0.25	-0.17
Refraction left eye, patients with 0 dpt	0.00	0.00	0.00
Refraction left eye, patients with myopia (-)	0.25	-0.08	0.33
Refraction left eye, patients with hyperopia (+)	-0.13	0.00	-0.13
Sciascopy right eye, patients with 0 dpt	-0.25	0.00	-0.25
Sciascopy right eye, patients with myopia (-)	0.00	0.00	0.00
Sciascopy right eye, patients with hyperopia (+)	-0.06	0.03	-0.09
Sciascopy left eye, patients with 0 dpt	0.00	-0.25	0.25
Sciascopy left eye, patients with myopia (-)		-0.25	0.25
Sciascopy left eye, patients with hyperopia (+)	-0.09	0.08	-0.17
Mean values	**0.07**	**-0.06**	**0.12**

Table 20

Accomodation in dpt

	Study group	Control group
Pre-test	12.93	14.17
Post-test	13.57	14.33
Difference	**-0.64**	**-0.17**

Table 21

6.4 Summary

First of all, it has to be pointed out that my original hypothesis that osteopathic treatment could improve asthenoptic complaints could statistically not be confirmed. Thus also no evidence could be provided for the positive effect of osteopathic interventions on observable behaviour or changes in the behaviour.

Nevertheless, certain tendencies can be identified in this study, which speak in favour of positive effects of osteopathic treatments on this kind of complaints. Thus further studies would be interesting to examine these tendencies in more detail. Table 22 below will summarize the results once more to illustrate these tendencies.
The results show that all examined categories (reading, writing, concentration, gross and fine motor skills and observable physical overstraining symptoms) have improved according to the impression of the parents of the study group. Positive changes are written in red in the table below.

Questions to the parents						
	Study group			**Control group**		
Category	**Pre-test**	**Post-test**	**Difference**	**Pre-test**	**Post-test**	**Difference**
Reading	33.48%	20.54%	**-12.95%**	32.29%	28.13%	**-4.16%**
Concentration	64.29%	48.21%	**-16.08%**	50.00%	44.79%	**-5.21%**
Observable physical overstraining symptoms	25.89%	21.43%	**-4.46%**	25.00%	26.04%	1.04%
Writing	43.15%	30.80%	**- 12.35%**	47.40%	43.23%	**- 4.17%**
Gross motor skills	26.79%	15.18%	**-11.61%**	18.75%	18.75%	0%
Fine motor skills	29.46%	25.89%	**-3.75%**	40.63%	39.58%	**-1.05%**

Table 22

In the categories reading, concentration, writing and fine motor skills also the parents of the control group observed positive changes in their children at the end of the study period. However, the degree of these changes is much smaller than in the study group.

In all the categories the children had to rate (reading, concentration and physical overstraining symptoms) the children of the study group indicated improvements at the end of the study period. The children of the control group only noticed an improvement in the category concentration. If the degrees of changes are compared between the two groups, again the children of the study group subjectively rated the changes better than the children of the control group. Table 23 below summarizes the results. Positive changes are marked in red.

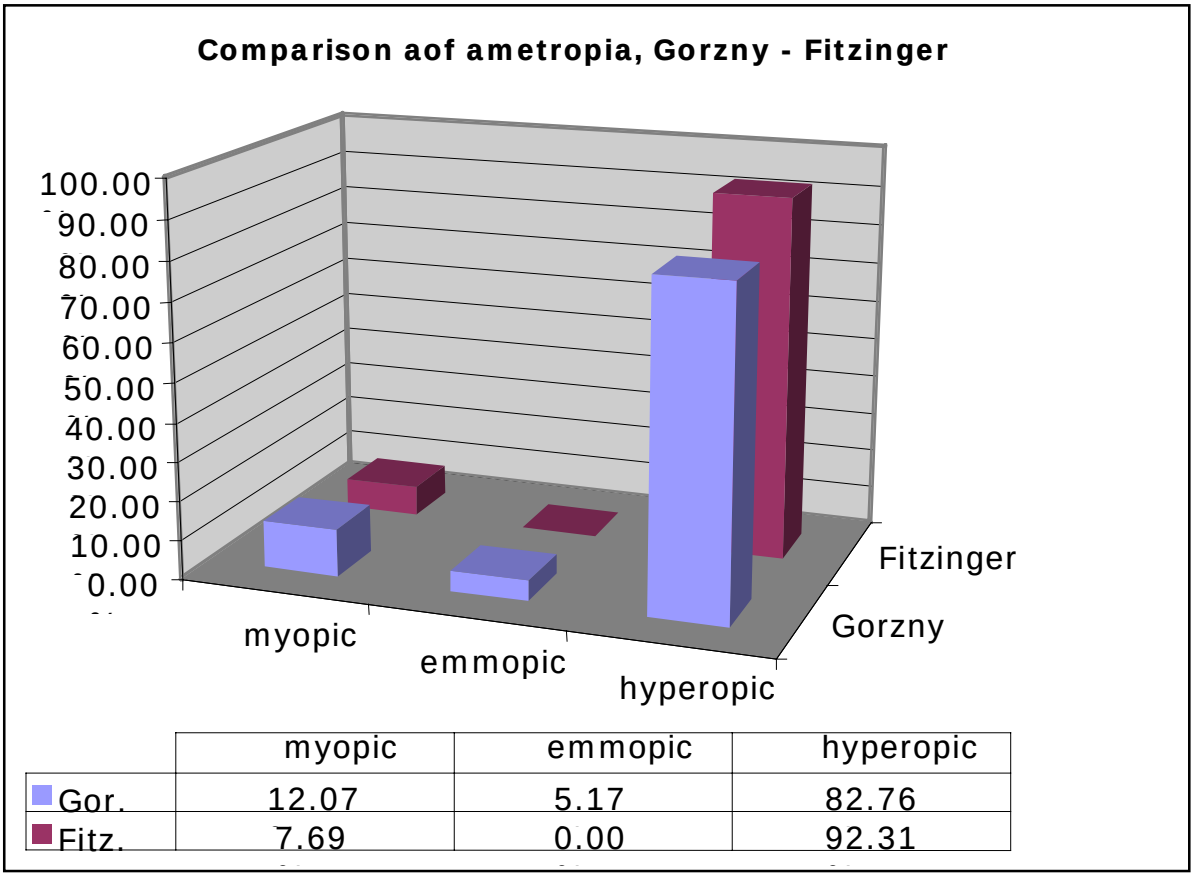
Questions to the children						
	Study group			**Control group**		
Category	**Pre-test**	**Post-test**	**Difference**	**Pre-test**	**Post-test**	**Difference**
Reading	33.25%	25.51%	**-7.74%**	29.46%	31.60%	2.14%
Concentration	36.25%	26.43%	**-9.82%**	34.17%	32.92%	**-1.25%**
Observable physical overstraining symptoms	48.81%	40.18%	**-8.63%**	39.58%	41.67%	2.09%

Table 23

The accompanying ophthalmologic measurements did also not show significant changes or differences between the study group and the control group.

I would like to refer to the study of Gorzny (2005) again to maybe point out some similarities with the “tendencies” observed in this study. It has already been mentioned that Gorzny examined a sample of 118 children to find out whether there was a connection between eye problems and reading/writing difficulties or ADHD.

In my sample 92.31 percent of the participants had a slight to moderate hyperopia. Gorzny observed this in 82.2 percent of his participants (cf. Diagram 7 below).



	myopic	emmopic	hyperopic
Gor.	12.07	5.17	82.76
Fitz.	7.69	0.00	92.31

Diagram 7

Differences between the participants in the two studies could be observed in the categories gross and fine motor skills. While in Gorzny’s study two thirds of the participants indicated problems of gross and fine motor skills, only one third of the participants did so in this study.

7 Conclusions

This chapter will summarize the data described in chapter 6 and try to provide explanations for the results of this study.

Unfortunately, some participants had to be excluded from the statistical analysis because some did not or only partially complete the second questionnaire or did not go to the second ophthalmologic examination.

Thus the data of 14 test persons of the study group and 12 test persons of the control group were available for analysis.

Due to the high drop-out rate of participants the results of this study are statistically not significant. Nevertheless, some carefully formulated tendencies can be identified.

The plausibility of the collected and used data is evaluated through the comparison with the results of Gorzny's study (2005), who had a sample of 31.36 percent female and 68.64 percent male participants.
The sample of the present study had a similar composition with 38.46 percent female and 61.54 percent male participants.
Also the findings of the ophthalmologic examinations and the measured dioptres bore the comparison with Gorzny's study. In his study population Gorzny (2005) found 12.07 percent myopia, 5.17 percent emmopia and 82.76 percent hyperopia.
The author of this study found 7.69 percent myopia, 0 percent emmopia and 92.31 percent hyperopia in his study population.
Thus the two studies were similar regarding gender distribution and ophthalmologic diagnoses.

In the category **reading** the parents of the study group observed a 9 percent better improvement than the parents of the control group; the children of the study group rated themselves 10 percent better than the children of the control group.

Also the reading behaviour changed favourably in the study group. While only about 15 percent of the participants in the study group declared to read more than 30 minutes per day at baseline, a share of 85 percent of the test persons did so at the end of the study period. In the control group the value did not change between the beginning and end of the study period. It remained steady at 50 percent.

In general positive changes could be observed in the category reading. The differences in the changes between the two groups speak in favour of the osteopathic treatment. However, it has already been mentioned several times that theses results have to be considered with the reservation that they are statistically not significant.

In the category **concentration** the difference between the ratings by the parents in the study group and in the control group was about 11 percent in favour of the osteopathic intervention. Also the children of both groups observed an improvement at the end of the study period. The difference between the two groups in the second rating was about 9 percent also in favour of the study group with the osteopathic treatment.

The parents and the children of both groups noticed improvements in this category at the end of the study period.
The tendency that can be observed in this category is that according to the estimates of both the parents and the children the changes were greater and more positive in the study group than in the control group.
Like in the category reading this is a tendency which could speak in favour of the osteopathic intervention.

In the category **observable physical overstraining symptoms** the rating of the parents in the study group showed a 5 percent improvement in comparison with the results at baseline. The difference between the two ratings of the children was even more pronounced with about 11 percent.

In this category it is interesting that the results of the study group improved, while those of the control group deteriorated (cf. 6.3.4). Thus also in this category the tendency speaks in favour of the osteopathic treatment.
In the categories **writing, gross and fine motor skills** improvements of 8, 12 and 3 percent could be observed in the study group.

The parents of both groups noticed positive changes in the categories writing and fine motor skills.
The gross motor skills also improved in the study group, while they remained unchanged in the control group.
The interpretation of the results can identify a tendency that the changes are considered as being greater and more positive by the parents in the study group than by the parents of the control group.
Again, this tendency might speak in favour of the osteopathic intervention.

When the ophthalmologic measurements of myopia, emmopia and hyperopia before and after the intervention are compared, no significant differences can be observed between the study group and the control group. Possibly a slight tendency of improvement can be observed in the accommodation, which could speak in favour of the osteopathic intervention.

Summarizing it can be said that the parents and children of the study group rated all categories after the intervention better than the parents and children of the control group after the study period of seven weeks without treatment.

This could provide some evidence that asthenoptic complaints can be influenced positively by osteopathic treatment.
Due to the high drop-out rate among the participants, however, the results are **statistically not significant** to support the hypothesis of this thesis.

8 Discussion and prospects

8.1 Study design

This clinical experimental study was organized as **pre-test post-test control group design,** thus it can be attributed to the group of **pragmatic randomized controlled studies**. This kind of design lends itself quite well for osteopathic clinical studies, despite some limitations.

The biggest problem in this context is the control group. Even though the parents have been informed and asked to abstain from additional external interventions (as long as this is ethically justifiable), decisive external influences cannot be completely excluded. Indicative for that are the post-test results of the control group which differ slightly from the pre-test results and in most cases show an improvement.

8.2 Study group/control group

The 39 participants were randomly attributed to the two groups; the study group comprised 20, the control group 19 test persons.
The parents were informed about the randomization procedure and no problems occurred in this context.

Unfortunately, some participants had to be excluded from the statistical analysis because some did not or only partially complete the second questionnaire or did not go to the second ophthalmologic examination.

Thus the data of 14 test persons of the study group and 12 test persons of the control group were available for analysis.

8.3 The questionnaire

The questionnaire was adopted with only two little changes (cf. 5.1.3) from Schroth (2003). The main reason for choosing this questionnaire was that it has already been used several times and that also Gorzny (2005) refers to this questionnaire in his study.

In retrospect a critical review of the questionnaire shows that its questions are formulated quite imprecisely. In most of the cases one question evaluates several physical, motor or sensory abilities of a child. For example: The question concerning “Mistakes in transcribing a text?” does not only concern the writing as such but also the concentration of the child.
Such questions are acceptable but it should be clarified what aspect the answer to the question really focuses on.
These kinds of problems and the remaining small sample population was the reason for summarizing the questions in categories (cf. 5.1.3.1) to maybe obtain significant results.

In order to compare the answers of the children with those of the parents it seemed necessary to ask the same questions. Another problem in this study was that the questions for the children did not include the categories gross and fine motor skills and writing so that these categories were only assessed by the parents.

At the beginning of this study I wanted to give the parents only few instructions or explanations regarding the completion of the questionnaire.
My opinion in this respect has changed. To guarantee that the parents are able to assess the performance of their children according to certain criteria it is of utmost importance to emphasize how crucial it is that the parents observe their children accurately.
What does it mean to stumble or to bump into something “often”? Three, four or ten times per day or within an hour? What does it mean to draw over a line “often”?

I think it would have been good a accompanying measure to ask the parents to keep a diary which contained the categories of the questionnaire. This would force the parents to **accurately observe** their children, which is usually not the case in the normal daily family life.

It could also be useful to integrate the teachers of the participants in the study, since this profession is trained to meticulously observe the children in their classes.

In the final evaluation of the results it was interesting to compare them with those of Gorzny (2005). He examined patients who came to his ophthalmologic practice with suspected reading/writing difficulties or ADHD with a sciascope and asked them to complete the questionnaire developed by Schroth (2003).

The findings of his ophthalmologic examinations provided almost the same results as the measurements in this study (cf. 6.4) and they also showed that a majority of the test persons (Gorzny: 82.76 percent, Fitzinger: 92.31 percent) suffered from hyperopia.
This contradicts the findings of Rössler (1994) who argues that the main cause for asthenoptic problems is an over-reactiveness of the eye.

8.4 Inclusion and exclusion criteria

In his explanation accompanying the questionnaire Schroth (2003) points out that an ophthalmologic examination is indicated if ‘three’, ‘four’ or ‘five’ are ticked “several times” as answers. It seemed necessary to define this more precisely: a questionnaire was regarded as positive if ‘five’ was marked one or several times, ‘four’ was chosen three or more times, and ‘three’ was selected six or more times as answer.

Considering the already collected data, future studies on the topic asthenopia should take into account the prevalence of hyperopia and consider this diagnosis as inclusion criterion.

8.5 Outcome measures and measuring instruments

8.5.1 Primary outcome measures

Also after the end of the study, a questionnaire as described in the chapter ‘Methodology’ (cf. 5.3) seems to be the best tool to collect data on the subjective symptoms of the participants. With slightly altered and improved questions the results could be even more unambiguous.

8.5.2 Secondary outcome measures

The ophthalmic examinations and the data obtained by them were regarded as secondary outcome measures. Like in the studies of Schäffer (1997) and Gorzny (2005) no significant change in the eyesight could be observed.
Nevertheless, the ophthalmic findings proved to be of value as secondary outcome measures. If the inclusion and exclusion criteria were altered as mentioned above, maybe interesting measurable changes could be observed also with regard to these findings.

8.5.3 Measuring instruments

The measuring instruments used in this study (cf. 5.3.3) are applied routinely in ophthalmic examinations and can be regarded as valid. They thus represent a standard in any study looking at an eye-related problem.
The Polar test mentioned in chapter 2.3, which is used by orthoptists in particular in Germany, represents a possible tool in addition to the tests mentioned in chapter 5.3.3 despite its disputed value.

8.6 Implementation of the study

8.6.1 Recruitment

280 students of the Hauptschule Timelkam (secondary school) received questionnaires; 72 questionnaires were returned and 40 met the inclusion and exclusion criteria.
The cooperation with a public institution proved to be quite helpful and productive. I would recommend this approach also for further studies.

8.6.2 Procedure and time frame

The planned duration of this study was 7 weeks. The participants of the study group received three treatments within this period, while the participants of the control group were not treated at all during this time.
In retrospect one could say, that maybe more frequent treatments in regular intervals (e.g. five treatments spaced at 2-week intervals) might have provided a more significant result.

The biggest problem in this study was to maintain the number of test persons (40) over the whole study period.
Even though the parents were very much interested in the approach, the return of the second questionnaire proved to be problematic in both the study group and the control group.

Due to this fact **no statistically significant** result could be obtained despite obviously better results in the study group.

One reason for the low return rate of the second questionnaire could be that it coincided with the end of school, where most of the parents and children already thought more about the upcoming holidays.

8.6.3 Case history and examination

"There is no pre-printed form for an osteopathic case history and examination"

(Sommerfeld, personal communication)

This was Peter Sommerfeld's answer when asked about a standardized case history and examination sheet.

The assumption in this study was that problems manifesting in different regions of the body can have an influence on the visual function (cf. 4.6). Therefore no set procedure was followed in the case history and examination. Only certain recommendations were taken into account (cf. 5.4.3.2).
The osteopathic intervention focused in particular on the regions of the body which have already been explored in more detail in chapter 2 (cf. 2.4).

When it comes to examine asthenopia, which basically is a description of symptoms (cf. 2), this seems to be an appropriate approach.

8.7 Intervention

The biggest points of criticism in the context of the osteopathic intervention are the skills and the experience of the osteopaths who delivered the treatment. However, the evaluation of these aspects is always subjective: What is a good osteopath? How can the skills of an osteopath be measured? How long does an osteopath need to be in practice to be regarded as experienced?

Maybe the results of this study would have been more significant if the participants had been treated by "more experienced" osteopaths.
In this context it has to be pointed out that one of the osteopaths who delivered the treatment has already been in practice for five years and thus already has a certain degree of experience in my opinion.
I could gather experience on this topic over a period of two years in my own practice.

Whether this gives me enough experience to be regarded as appropriate therapist for this study remains to be seen and has to be judged by “more experienced” colleagues.

8.8 Prospects

The topic “vision” is a field that is still only little explored in osteopathy. Thus I would like to encourage all colleagues to maybe look further into this very interesting subject area.
The suggestion regarding changes or adaptations in the study design (cf. chapter 8) should provide a more significant result which would give osteopathy a medical justification to work with patients who suffer from asthenoptic problems.
It is definitely recommendable to retain the design as randomized controlled clinical study because of its high level of evidence. According to my experience it can be implemented without major problems in cooperation with public institutions.

“Relaxed vision” is one of the most important preconditions for children to cope with the ever increasing pressure at school.

Osteopathy could be one possibility to achieve this “relaxed vision” in a gentle and easy way.

I hope that this paper can motivate colleagues to carry out similar studies to maybe provide statistically significant proof of my hypothesis.

Annex

List of abbreviations

A.	artery
ADHD	attention deficit hyperactivity disorder
C	cervical segment
dpt	dioptres
Lig.	ligament
Ligg.	ligaments
M.	muscle
Mm.	muscles
N.	nerve
Nn.	nerves
Proc.	process
S	sacral segment
SBS	sphenobasilar symphesis
T	thoracic segment
V.	vein

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Name/Vorname des Kindes .....

Geb.: ..... Klasse: .....

Datum: .....

Telefonisch erreichbar unter: .....

1. Fragen an die Eltern

Bitte markieren Sie die zutreffende Zahl auf der Skala von 1 bis 5

1 = nicht zutreffend **5** am stärksten zutreffend

	1	2	3	4	5
Stockendes, buchstabierendes Lesen?					
Häufiges Verrutschen in der Zeile beim Lesen?					
Auffällige Kopfhaltung beim Lesen?					
Liest große Schrift besser als kleine Schrift?					
Oft Augenreiben, Blinzeln oder Stirnrunzeln?					
Verminderte Konzentrationsfähigkeit?					
Beim Schreiben können Linien nicht gut gehalten werden?					
Unregelmäßige Schrift beim längeren Schreiben?					
Beim Ausmalen oft über die Linien malen?					
Nicht gern basteln, puzzeln, mit der Schere schneiden?					
Fehler beim Abschreiben von einer Vorlage?					
Schlecht Bälle fangen, Probleme bei Federball o. ä.?					
Oft anrempeln oder stolpern?					

2. Fragen an das Kind

	Ja	Nein
Liest du in deiner Freizeit?	○	○

Wenn „JA“, wie viele Minuten am Stück liest du dann meistens?

Bis 10 Min. ○ bis 30 Min. ○ mehr als 30 Min. ○

	1	2	3	4	5
Wird Lesen anstrengender, je länger du liest?					
Tränen oder brennen die Augen beim Lesen?					
Erscheint Druckschrift unscharf oder verschwommen?					
Sind Buchstaben unruhig oder wackeln?					
Wird Schrift kurzzeitig wie doppelt?					
Ist für dich schlecht zu erkennen, was an der Tafel steht?					
Ist der Blickwechsel vom Heft zur Tafel schwierig?					
Ist der Blickwechsel von der Tafel zum Heft schwierig?					
Werden die Augen beim Fernsehen oder Videospielen müde?					
Bist Du von hellem Licht schnell geblendet?					
Hast du Kopfschmerzen?					

uestions to the child

Do you have pain?
If yes, where, how and since when?

Do you have any chronic condition?

Did you have accidents/fractures or falls in the past (e.g. on the head or bottom)?

Did you have an operation (scars)?

Do you have problems or pain in your organs (lungs, heart, stomach, liver, gallbladder, pancreas, kidneys, digestive system)?
If yes, why?

Do you take any medication?
Do you have allergies?

Do you suffer from headaches or do you feel dizzy sometimes?
If yes, why?

Did you have to wear braces or did you have any other orthodontist treatment?

Questions to the parents

Did any complications occur during the pregnancy?

Please, describe the birth process briefly in your own words.

How was the development during your child's first year of life (e.g. lying prone, crawling, walking)?

Did your child already receive treatment?
If yes, where?

Studiengruppe - Pre-Test

Bogennummer	2	5	6	8	9	11	12	13	14	15	16	17	19	20	
Datum	17.3.07	13.4.07	28.3.07	19.3.07	23.3.07	18.3.07	26.3.07	24.3.07	17.3.07	26.3.07	18.3.07	22.3.07	19.3.07	19.3.07	
Geburtsdatum	4.4.94	27.1.95	9.12.92	22.11.95	27.9.94	10.7.93	11.10.92	19.6.93	7.3.93	17.2.95	9.5.95	22.4.96	18.7.95	5.6.96	
Klasse	3	2	4	1	2	3	4	3	3	2	1	1	1	1	MW
Eltern 1	0%	25%	75%	25%	75%	0%	25%	100%	50%	25%	0%	50%	25%	0%	33,93%
Eltern 2	25%	0%	25%	0%	100%	0%	25%	25%	50%	25%	0%	25%	75%	25%	28,57%
Eltern 3	0%	25%	0%	0%	50%	50%	50%	0%	25%	0%	50%	25%	100%	0%	26,79%
Eltern 4	100%	75%	0%	100%		25%	50%	25%	25%	25%	0%	50%	50%	25%	42,31%
Eltern 5	50%	50%	0%	75%	25%	0%	50%	0%	25%	25%	0%	0%	50%	0%	25,00%
Eltern 6	50%	50%	75%	50%		100%	75%	100%	50%	100%	50%	50%	100%	75%	71,15%
Eltern 7	25%	25%	50%	100%		25%	50%	25%	0%	25%	0%	0%		25%	29,17%
Eltern 8	25%	50%	75%	75%	75%	75%	50%	50%	0%	50%	75%	0%	75%	25%	50,00%
Eltern 9	0%	25%	25%	100%	25%	50%	25%	0%	0%	50%	0%	0%	75%	50%	30,36%
Eltern 10	0%	100%	0%	25%	0%	25%	25%	0%	0%	50%	50%	0%		50%	25,00%
Eltern 11	25%	50%	25%	25%	75%	100%	50%	75%	50%	50%	75%	0%	100%	100%	57,14%
Eltern 12	25%	0%	25%	50%	100%	25%	0%	0%	50%	25%	0%	0%	100%	50%	32,14%
Eltern 13	25%	25%	0%	0%	75%	25%	25%	0%	25%	75%	0%	0%	75%	25%	26,79%
	26,92%	38,46%	28,85%	48,08%	60,00%	38,46%	38,46%	30,77%	26,92%	40,38%	23,08%	15,38%	75,00%	34,62%	36,80%
Kind Lesen	0	0	1	0	1	1	0	0	1	1	0		0	1	
Minuten	3	2		1			2	2			2		1		
Kind 1	25%	75%	50%	100%	100%	100%	0%	75%	0%	50%	0%	50%	75%	0%	50,00%
Kind 2	50%	75%	25%	25%	100%	75%	0%	75%	25%	25%	0%	75%	100%	0%	46,43%
Kind 3	0%	25%	0%	25%	100%	0%	0%	100%	25%	0%	0%	75%	50%	0%	28,57%
Kind 4	0%	0%	0%	75%	100%	0%	0%	100%	0%	0%	0%	25%	25%	0%	23,21%
Kind 5	0%	0%	25%	75%	100%	0%	0%	100%	50%	0%	0%	25%	0%	25%	28,57%
Kind 6	25%	50%	0%	0%	100%	0%	0%	100%	0%	0%	0%	50%	75%	0%	28,57%
Kind 7	25%	75%	25%	25%	75%	0%	0%	100%	50%	0%	0%	50%	100%	0%	37,50%
Kind 8	25%	75%	25%	25%	100%	0%	0%	100%	0%		0%	50%	100%	0%	38,46%
Kind 9	75%	50%	50%	75%	25%	0%	0%	50%	0%	25%	50%	50%	0%	100%	39,29%
Kind 10	75%	100%	50%	100%	50%	100%	25%	50%	50%	50%	50%	50%	100%	100%	67,86%
Kind 11	75%	50%	50%	75%		50%	100%	75%	0%	0%	50%	0%	0%	0%	40,38%
	34,09%	52,27%	27,27%	54,55%	85,00%	29,55%	11,36%	84,09%	18,18%	15,00%	13,64%	45,45%	56,82%	20,45%	38,99%

Studiengruppe - Post-Test

Bogennumme	2	5	6	8	9	11	12	13	14	15	16	17	19	20	
Datum	4.7.07	24.6.07	5.7.07	23.4.07	17.6.07	10.7.07	21.6.07	17.6.07	15.6.07	5.5.07	4.7.07	15.6.07	26.6.07	6.7.07	MW
Eltern 1	0%	25%	50%	0%	0%	25%	0%	50%	50%	25%	0%	50%	25%	0%	21,43%
Eltern 2	25%	0%	25%	0%	0%	25%	0%	25%	0%	0%	0%	25%	75%	0%	14,29%
Eltern 3	0%	0%	0%	0%	0%	25%	25%	0%	25%	25%	50%	0%	75%	0%	16,07%
Eltern 4	25%	25%	0%	0%	0%	50%	25%	100%	100%	25%	0%	25%	25%	25%	30,36%
Eltern 5	25%	25%	0%	0%	25%	50%	25%	75%	75%	0%	50%	25%	0%	0%	26,79%
Eltern 6	0%	50%	25%	0%	0%	75%	25%	100%	100%	50%	50%	25%	100%	100%	50,00%
Eltern 7	25%	25%	25%	25%	0%	25%	25%	25%	50%	0%	0%	0%	75%	25%	23,21%
Eltern 8	0%	25%	50%	25%	25%	50%	0%	50%	50%	25%	75%	0%	75%	25%	33,93%
Eltern 9	0%	25%	0%	25%	25%	25%	0%	0%	0%	50%	25%	0%	50%	50%	19,64%
Eltern 10	0%	75%	0%	0%	100%	75%	0%	50%	0%	50%	0%	0%	50%	50%	32,14%
Eltern 11	25%	25%	25%	0%	0%	100%	50%	50%	50%	50%	50%	25%	100%	100%	46,43%
Eltern 12	0%	0%	0%	25%	25%	50%	0%	0%	25%	25%	0%	0%	25%	0%	12,50%
Eltern 13	0,00%	25,00%	0,00%	0,00%	25,00%	25,00%	25,00%	0,00%	0,00%	50,00%	0,00%	0,00%	75,00%	25,00%	17,86%
	9,62%	25,00%	15,38%	7,69%	17,31%	46,15%	15,38%	40,38%	40,38%	28,85%	23,08%	13,46%	57,69%	30,77%	26,51%
Kind Lesen	0	1	1	0	0	0	0	0	1	1	0	0	0	0	
Minuten	3			3	3	1	3	2			3	2	1	2	
Kind 1	25%	25%	50%	0%	25%	100%	0%	50%	100%	25%	0%	50%	75%	0%	37,50%
Kind 2	0%	25%	25%	0%	50%	0%	0%	75%	100%	25%	0%	50%	0%	25%	26,79%
Kind 3	25%	0%	0%	0%	0%	50%	0%	100%	100%	25%	0%	75%	0%	0%	26,79%
Kind 4	0%	0%	0%	25%	0%	0%	0%	100%	50%	25%	0%	50%	0%	0%	17,86%
Kind 5	25%	0%	0%	0%	100%	50%	0%	100%	0%	0%	0%	50%	50%	25%	28,57%
Kind 6	25%	25%	0%	0%	0%	0%	0%	100%	100%	25%	0%	0%	25%	0%	21,43%
Kind 7	0%	50%	0%	0%	0%	0%	0%	100%	100%	25%	0%	0%	75%	0%	25,00%
Kind 8	25%	50%	0%	0%	0%	0%	0%	100%	100%	25%	0%	0%	0%	0%	21,43%
Kind 9	25%	50%	75%	0%	100%	0%	75%	75%	100%	0%	75%	0%	0%	25%	42,86%
Kind 10	25%	75%	0%	25%	100%	100%	50%	75%	50%	0%	100%	50%	75%	25%	53,57%
Kind 11	25%	25%	50%	25%	0%	50%	100%	50%	75%	0%	0%	50%	50%	25%	37,50%
	18,18%	29,55%	18,18%	6,82%	34,09%	31,82%	20,45%	84,09%	79,55%	15,91%	15,91%	34,09%	31,82%	11,36%	30,84%

Kontrollgruppe - Pre-Test

Bogennumme	21	22	23	25	26	27	32	33	34	35	36	38	
Datum	25.3.07	16.3.07	24.3.07	18.3.07	16.3.07	17.3.07	18.3.07	19.3.07	13.4.07	16.3.07	15.3.07	19.3.07	
Geburtsdatum	8.7.94	8.3.93	18.5.94	27.4.94	16.7.95	13.12.94	25.7.96	10.12.95	13.4.91	12.5.95	24.8.93	22.8.93	
Klasse	3	3	3	2	2	2	1	1	4	2	4	3	MW
Eltern 1	50%	100%	25%	50%	0%	50%	50%	0%	100%	0%	0%	50%	39,58%
Eltern 2	25%	50%	25%	0%	0%	25%	75%	50%	50%	25%	0%	0%	27,08%
Eltern 3	0%	25%	0%	0%	0%	0%	25%	50%	75%	0%	50%	0%	18,75%
Eltern 4	0%	100%	25%	50%	50%	100%	0%	0%	100%	0%	25%	75%	43,75%
Eltern 5	25%	25%	25%	0%	100%	50%	25%	25%	75%	0%	25%	0%	31,25%
Eltern 6	100%	50%	75%	75%	50%	100%	50%	50%	75%	0%	25%	0%	54,17%
Eltern 7	75%	50%	75%	50%	0%	100%	0%	50%	50%	50%	0%	100%	50,00%
Eltern 8	75%	50%	50%	75%	25%	100%	25%	50%	50%	0%	25%	100%	52,08%
Eltern 9	50%	25%	75%	50%	25%	100%		50%	25%	0%	0%	75%	43,18%
Eltern 10	50%	50%	100%	50%	0%	75%	0%	50%	75%	0%	0%	50%	41,67%
Eltern 11	50%	50%	50%	75%	25%	25%	50%	25%	50%	25%	25%	100%	45,83%
Eltern 12	50%	75%	0%	0%	25%	0%	25%	0%	25%	25%	0%	0%	18,75%
Eltern 13	0%	25%	25%	0%	0%	75%	75%	25%	0%	0%	0%	0%	18,75%
	42,31%	51,92%	42,31%	36,54%	23,08%	61,54%	33,33%	32,69%	57,69%	9,62%	13,46%	42,31%	37,30%
Kind Lesen	0	1	1	1	1	0	0	0	1	0	0	0	
Minuten	1	8	8	8	8	1	3	3	8	2	2	1	
Kind 1	50%	50%	75%	50%	25%	25%	50%	75%	100%	50%	50%	75%	56,25%
Kind 2	50%	0%	50%	0%	25%	75%	0%	0%	50%	0%	75%	0%	27,08%
Kind 3	25%	0%	0%	0%	0%	0%	25%	25%	50%	0%	50%	0%	14,58%
Kind 4	0%	50%	0%	0%	0%	0%	0%	25%	25%	0%	100%	0%	16,67%
Kind 5	0%	0%	25%	0%	0%	0%	25%	75%	25%	0%	75%	0%	18,75%
Kind 6	25%	50%	0%	25%	25%	25%	50%	25%	25%	50%	75%	0%	31,25%
Kind 7	50%	75%	0%	25%	50%	25%	25%	75%	25%	50%	75%	25%	41,67%
Kind 8	50%	75%	0%	25%	25%	25%	25%	25%	25%	0%	25%	25%	27,08%
Kind 9	75%	0%	0%	50%	75%	25%	75%	75%	50%	100%	25%	75%	52,08%
Kind 10	50%	100%	25%	0%	25%	75%	100%	100%	25%	0%	50%	75%	52,08%
Kind 11	0%	25%	25%	0%	0%	50%	25%	100%	75%	0%	25%	0%	27,08%
	34,09%	38,64%	18,18%	15,91%	22,73%	29,55%	36,36%	54,55%	43,18%	22,73%	56,82%	25,00%	33,14%

Kontrollgruppe - Post-Test

Bogennumme	21	22	23	25	26	27	32	33	34	35	36	38	
Datum	21.6.07	4.7.07	16.6.07	24.6.07	4.7.07	19.7.07	22.6.07	26.6.07	24.6.07	5.6.07	18.6.07	4.7.07	MW
Eltern 1	0%	50%	0%	50%	0%	75%	25%	0%	50%	0%	0%	75%	27,08%
Eltern 2	25%	50%	0%	25%	0%	50%	0%	75%	50%	0%	0%	0%	22,92%
Eltern 3	0%	25%	0%	0%	25%	50%	0%	25%	25%	0%	25%	0%	14,58%
Eltern 4	75%	75%	0%	0%	25%	100%	100%	50%	75%	0%	25%	50%	47,92%
Eltern 5	75%	25%		25%	50%	75%	0%	100%	75%	0%	25%	0%	40,91%
Eltern 6	100%	75%	50%	50%	25%	100%	0%	50%	75%	0%	25%	0%	45,83%
Eltern 7	50%	50%	25%	50%	25%	100%	50%	75%	50%	0%	0%	100%	47,92%
Eltern 8	50%	75%	25%	25%	25%	100%	0%	100%	50%	0%	25%	75%	45,83%
Eltern 9	25%	50%	0%	75%	0%	100%	25%	75%	0%	0%	0%	75%	35,42%
Eltern 10	0%	50%	50%	75%	0%	100%	50%	75%	25%	0%	25%	75%	43,75%
Eltern 11	75%	75%	25%	50%	0%	100%	0%	50%	25%	0%	25%	100%	43,75%
Eltern 12	25%	50%	0%	0%	0%	25%	0%	50%	50%	0%	25%	0%	18,75%
Eltern 13	25%	25%	25%	0%	0%	75%	0%	50%	25%	0%	0%	0%	18,75%
	40,38%	51,92%	16,67%	32,69%	13,46%	80,77%	19,23%	59,62%	44,23%	0,00%	15,38%	42,31%	34,88%
Kind Lesen	1	1	1	1	1	0	0	0	1	1	0	0	
Minuten	8	8	8	8	8	2	2	3	8	8	3	2	
Kind 1	50%	50%	50%	50%	50%	100%	50%	100%	100%	25%	75%	0%	58,33%
Kind 2	50%	50%	75%	25%	25%	100%	25%	75%	50%	0%	75%	25%	47,92%
Kind 3	25%	25%	0%	0%	0%	100%	50%	75%	25%	0%	75%	25%	33,33%
Kind 4	0%	50%	0%	0%	0%	100%	25%	100%	25%	0%	50%	0%	29,17%
Kind 5	0%	75%	25%	0%	0%	50%	25%	75%	0%	0%		25%	25,00%
Kind 6	0%	50%	0%	25%	25%	25%	0%	0%	0%	0%	25%	0%	12,50%
Kind 7	50%	50%	0%	25%	25%	50%	50%	50%	0%	25%	50%	0%	31,25%
Kind 8	50%	50%	0%	25%	25%	25%	25%	75%	0%	25%	50%	0%	29,17%
Kind 9	50%	50%	0%	25%	50%	25%	100%	75%	25%	50%	25%	50%	43,75%
Kind 10	50%	75%	50%	0%	25%	75%	100%	100%	25%	0%	75%	50%	52,08%
Kind 11	0%	25%	25%	0%	25%	50%	0%	75%	50%	0%	25%	0%	22,92%
	29,55%	50,00%	20,45%	15,91%	22,73%	63,64%	40,91%	72,73%	27,27%	11,36%	52,50%	15,91%	35,04%

Declaration of consent

I agree that the data

of my child.....(name of the child)

Class: .....

collected within the framework of the osteopathic study:

Relaxed Vision

Can osteopathic treatment influence asthenoptic complaints in a positive way?

are published.

In addition, I consent to an ophthalmologic examination of my child at the beginning and end of the study period as well as three consecutive osteopathic treatments.

The personal data of the child remain anonymous.

....

Place, date Signature of parent