INTERNATIONALE VEREINIGUNG FÜR BINOKULARES SEHEN

IVBS

INTERNATIONAL ASSOCIATION FOR BINOCULAR VISION

Measuring and **C**orrecting Methodology according to H.-J. **H**aase

MCH Guidelines

Rules of practice for successful prismatic corrections

Version 5.01 - 2024

...simply good vision.

MCH Guidelines

Rules of practice for successful prismatic corrections

Fifth, completely revised
and upgraded edition

Version 5.01 – 2024

Preface to the first edition

Over the years, several instructors have developed various approaches and recommendations of their own for the use of the Polatest vision testing instrument in binocular correction.

A considerable number of these instructors have kindly discussed their ideas in detail with me. This has resulted in some additions or modifications to my original recommendations. Other new suggestions were recognised as unsuitable and were discarded.

However, some other instructors did not even attempt to consult me at all or persisted with their ideas despite previous discussions with me. Confusing contradictions which sometimes resulted from this prompted the IVBS to plan uniform guidelines for MCH.

Several experienced MCH practitioners jointly commenced their work on the compilation of these guidelines in September 1992. The two initial discussions took place in Hamburg in order to give me an opportunity to directly contribute my opinions and to recount my own recent personal experience.

The guidelines resulting from a total of six extensive meetings of the IVBS working group concisely summarise the essentials of my methodology. I very much welcome the fact that rules have now been formulated, the consistent observance of which should be seen as indispensable and obligatory for the practical application of MCH.

I am extremely grateful to the working group for providing me with an opportunity to participate in this undertaking.

Hamburg, April 1995

Hans-Joachim Haase

Preface to the second edition

I was delighted at the success of the first edition of the guidelines for the correction of associated heterophoria. Discussions held on certain points of the guidelines and questions arising on subjects not dealt with before have led to a further revision and addition to these guidelines. For instance, the important chapter on the application of the near tests has been added.

I can once again confirm that the use of my methodology is correctly described in these extended guidelines. I would therefore be very grateful if all users accepted these IVBS guidelines as binding and hope that the scientific advisory committee of the IVBS will continue its endeavours to enhance the guidelines in the future.

Hamburg, March 1997

Hans-Joachim Haase

Preface to the fifth edition ("MCH 5.0")

The rules of practice have been fundamentally revised for this new edition. In the interests of consistent further development of the MCH, numerous changes have been made, starting with terms, through components of the examination to application rules for individual tests. Both practical experience and the current state of specialist knowledge were taken into account.

This new version takes into account the importance of Haase's methodology, which goes far beyond the application of certain heterophoria tests: MCH is an indispensable component of a modern, forward-looking optometric examination.

For decades, successful MCH-based corrections have emphasised the importance of the practical application of the method in solving binocular vision problems – regardless of whether and when science finds explanations for these successes.

These guidelines are intended to help MCH practitioners use this proven technique for the benefit of their patients.

Flacht, October 2021

Scientific Advisory Committee of the IVBS

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1 Preliminary remarks

1.1 Structure and objectives of the IVBS

The **I**nternationale **V**ereinigung für **B**inokulares **S**ehen (International Association for Binocular Vision) was founded in 1988 under the name **IVBV** (**I**nternationale **V**ereinigung für **B**inokulare **V**ollkorrektion = International Association for Binocular Full Correction). In this association, which is registered in Switzerland, members of different professional groups work together on an interdisciplinary basis towards the goal of achieving optimum vision. These include, for example, opticians/optometrists, ophthalmologists, orthoptists, teachers, occupational therapists, remedial teachers, dyslexia therapists and speech therapists.

Unimpaired binocular vision is an important prerequisite for optimum vision. This realisation prompted Hans-Joachim Haase to think about new measurement techniques back in the mid-1950s, making him a pioneer in the field of binocular correction. The method he developed was initially known as the "Polatest method" and is now referred to as MCH (Measuring and Correcting Methodology according to H.-J. Haase).

Regarding the frequency of heterophoria, the literature states (quote): *"Statistical studies (Tait, 1951) have shown that heterophoria occurs in 70-80% of the population."* [1]

Decades of experience show that most patients can only achieve symptom-free binocular vision with a prismatic correction determined according to MCH. It is therefore the declared aim of the IVBS to disseminate MCH and to incorporate new scientific findings into its further development.

The annual congresses of the IVBS, as well as various regional events, to which all interested parties are cordially invited, serve this purpose.

By publishing these guidelines, the IVBS aims to promote the standardised and correct application of MCH.

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[1] Steffen H, Kaufmann H, Strabismus. Hrsg. 5., vollständig überarbeitete Auflage. Stuttgart: Thieme (2020); S. 11

1.2 Terms

Dissociated heterophoria vs. associated heterophoria

The result of each measurement depends on the respective measurement conditions. In the case of latent resting position errors, Ogle et al. already distinguished between dissociated and associated heterophoria, whereby "dissociated" refers to measurements in the absence of fusion stimuli and "associated" to measurements in the presence of fusion stimuli.[2] It would therefore be correct to specify the measurement method used for each result (examples: "dissociated heterophoria, measured with the Maddox rod test", "associated heterophoria, measured with the Mallett unit").

MCH exclusively applies tests with fusion stimuli and therefore belongs to the procedures for measuring associated heterophoria. The designation is based on the term "associated phoria" commonly used in the English-speaking world.

The colloquial name "angular ametropia" was introduced to make it easier for patients to understand the term "associated heterophoria measured using MCH".

However, the standardised technical term is "heterophoria" and is defined as follows: "Deviation of the vergence position from the ortho position with partial or complete elimination of the fusion."

The terms "heterophoria" and "dissociated heterophoria" are often used interchangeably in the literature. However, it seems sensible to use "heterophoria" as a neutral generic term. The respective sub-term depends on the measurement method used.

Accordingly, the standard now also states the following: "Depending on the measurement method used, dissociated heterophoria (without fusion stimuli) or associated heterophoria (with fusion stimuli) is measured." [3]

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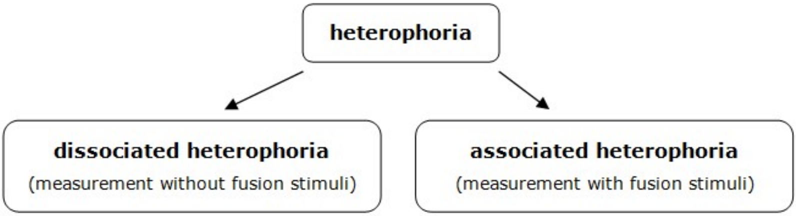
[2] K.N. Ogle, T.G. Martens, J.A. Dyer: "Oculomotor imbalance in binocular vision and fixation disparity", Lea & Febiger, Philadelphia 1967, 43-45
[3] DIN 5340:2022-11 "Begriffe der physiologischen Optik"



For correction purposes, only the associated heterophoria is relevant. Therefore – and to facilitate the readability of these guidelines – the term "heterophoria" is always used below in the sense of "associated heterophoria, measured using MCH".

Fixation disparity vs. fixation disparation

DE: Fixationsdisparität vs. Fixationsdisparation

The terms "fixation disparity" and "fixation disparation" are considered synonymous, but until now, "fixation disparation" has mostly been used. Based on the meaning of the word, however, "fixation disparation" describes a *process*. It is therefore linguistically correct to speak of "fixation disparity" because this refers to the *state* resulting from the disparation.[3] The term "fixation disparity" is therefore used below.

Fixation disparity

Abbrevation: FD

DE: Fixationsdisparität

Fixation disparity is a condition of normal binocular single vision in which the fixation point is imaged with a disparity within the associated Panum's area. Depending on the cause, a distinction is made between dynamic, transitory and heterophoria-related fixation disparity. These three natural fixation disparities must be distinguished from artificially induced fixation disparities.

In addition, a distinction is made between objective and subjective fixation disparity.[3]

Dynamic FD

DE: Dynamische FD

Dynamic fixation disparity is a small fixation disparity that is caused by micro-movements of the eyes.

Dynamic fixation disparity constantly changes its direction and size.

Transitory FD

DE: Transitorische FD

Transitory fixation disparity is an exo-fixation disparity that occurs when looking at close objects during simple visual tasks, analogous to accommodation deficit.

Heterophoria-related FD
(formerly: static FD)

DE: Heterophoriebedingte FD (vormals: statische FD)

Heterophoria-related fixation disparity is a fixation disparity that occurs in heterophoria when the fusional vergence requirement is not completely covered by fusional vergence.

Vision with heterophoria-related fixation disparity leads to a lateral image location error. The direction of this FD is determined by the direction of the heterophoria. Heterophoria-related FD is reversible with full prismatic correction.

Induced FD
Synonym: Prismatic FD

DE: Induzierte FD, Synonym: Prismatische FD

Induced fixation disparity is a fixation disparity that occurs in orthophoria when the fusional vergence demand artificially generated by a prism is not completely covered by fusional vergence.

Objective FD

DE: Objektive FD

Objective fixation disparity is the measured difference between the ortho position and the vergence working position of the eye. Measurement methods include eye tracking and the scleral search coil system.[3]

Subjective FD

DE: Subjektive FD

Subjective fixation disparity is the magnitude of the perceived offset between two visual objects presented separately to each eye in the presence of fusion stimuli.[3]

Since MCH is a subjective measurement method, these guidelines refer exclusively to subjective fixation disparity.

Disparate fusion
Synonym: Type one fixation disparity / FD I

DE: Disparate Fusion, Synonyme: FD erster Art, FD I

Disparate fusion is a fixation disparity resulting from heterophoria that is no longer fully compensated for by motor function, but in which bicentral correspondence still exists.

Disparate correspondence
Synonym: Type two fixation disparity / FD II

DE: Disparate Korrespondenz, Synonyme: FD zweiter Art, FD II

Disparate correspondence is a fixation disparity resulting from heterophoria that is no longer fully compensated by motor function, in which bicentral correspondence no longer exists.

This means that the directional value "straight ahead" has been shifted from the foveal centre of the deviating eye (FD eye) to the disparate retinal location used for fixation.

As sensory adaptation to the misalignment (FD position) progresses, the change in the directional value also extends to the surrounding retinal areas.

MCH has the potential to differentiate among six subtypes of disparate correspondence depending on the test perception (see Chapter 17).

Intermittent FD (formerly: young FD)

DE: Intermittierende FD (vormals: junge FD)

Intermittent fixation disparity is a fixation disparity in which demanding visual tasks (e.g., stereoscopic vision) trigger motor compensation for the misalignment due to only a "loose" sensory adaptation.

Since the sensory adaptation is still relatively weak, the FD position and the ortho position are used alternately (intermittent = occurring temporarily or alternately with another state).

Intermittent FD comprises disparate fusion (FD I) and the first two subtypes of disparate correspondence (FD II/1-2).

Consolidated FD (formerly: old FD)

DE: Verfestigte FD (vormals: alte FD)

Consolidated fixation disparity is a fixation disparity in which, as a result of sensory adaptation that has since become manifest, even demanding visual tasks no longer trigger motor compensation for the misalignment.

In consolidated FD, there is always disparate correspondence of the third to sixth subtypes (FD II/3-6). These conditions are reversible with MCH correction.

The previously used terms "young" and "old" FD often led to the misunderstanding that there was a connection with the patient's age. In fact, even young people can have consolidated FD.

Fundamentals for measuring fixation disparity

Special tests are required to detect all components of subjective, heterophoria-related FD:

- **Conventional heterophoria test**
  A conventional test is used to determine motorically compensated components of heterophoria and/or disparate fusion.

  MCH uses the cross test for this purpose. Another example of a conventional heterophoria test is the polarising Schober test (with peripheral fusion stimulus).

- **Classical FD tests** (with a central fusion object*)
  Classical FD tests indicate disparate correspondence if parts of the test are projected onto paracentral retinal regions which have not yet been captured by a change of oculocentric direction.

  MCH uses the pointer test, the double pointer test and the rectangle test for this purpose. Other classical FD tests are the Mallett unit fixation disparity test and the Grolman angle-cross test.

- **Stereopsis tests**
  Stereopsis tests provide indications of disparate correspondence when changes of oculocentric directions have already spread to the retinal periphery.

  MCH uses the stereo delay test, the stereo dominance test and the stereo acuity test for this purpose. Another example of a stereopsis test is the Osterberg stereo test.

**An FD test that is intended to reliably indicate whether the displayed FD is also present in natural vision must necessarily contain a central fusion object. However, there are also tests without a central fusion object that are used to measure fixation disparity, e.g., by Sheedy or Saladin.*

Since a release of eye muscle tone may occur with any test, there is no reliable distinction between the parts of motor compensation and fixation disparity. Therefore, MCH does not claim to accurately measure the extent of heterophoria-related FD.

H.-J. Haase also pointed this out, saying, *"These two phoria components cannot be separated precisely from one another."* [4] The classic FD tests and stereopsis tests used serve as important indicators for the direction and the approximate size of a disparate correspondence.

However, this aspect does not affect the practical application of the tests.

1.3 Basic concept of MCH

For a better understanding and precise classification of MCH in the catalogue of heterophoria measurement methods, the basic concept of Haase's methodology and its history will first be presented in a compact and simplified form.

All concepts assume that heterophoria is a misalignment of the eyes that can be compensated for by the extraocular muscles. In this case, there is no misalignment in unaided vision. The error is therefore not visible from the outside; it is hidden (Latin: latent). This allows binocular vision to develop fully and ideally, albeit with additional muscular strain, which in some cases can lead to strain-related symptoms. To measure latent resting errors, fusion is completely suspended in classic procedures (such as Maddox, von Graefe). This is intended to allow the pair of eyes to assume their resting position of vergence.

However, prismatic corrections determined with fusion *completely* suspended have not proven successful, as in many cases they did not satisfactorily reduce the symptoms or the correction was incompatible.[5] Therefore, correction rules (e.g., by Maddox, Sheard, Percival, Schober, von Graefe) were defined according to which the actual measured value should be modified. However, the resulting under-corrections were often unsuccessful, so that even today there is considerable uncertainty among experts – both in ophthalmic optics/optometry and in ophthalmology – regarding the treatment of heterophoria.

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[4] H.-J. Haase: "Die sensorischen Anomalien des Binokularsehens auf der Grundlage von Stellungsfehlern", Unterrichtsskript SFOF Berlin (1975)
[5] R.A. Crone: "Heterophoria", A. von Graefes Arch. klin. exp. Ophthal. 177:52-73 (1969)

Many ophthalmologists no longer devote themselves to this field at all and delegate the work to an orthoptist.

H.-J. Haase initially followed the approach of approximating the conditions for measuring heterophoria as closely as possible to those in natural vision. He therefore demanded that measurements be carried out in a bright room, with visual stimuli that were as similar as possible for both eyes in terms of colour, contrast, luminance, etc., and with only *moderately reduced* fusion stimuli—i.e., without *completely* eliminating fusion. He found that the prismatic correction values determined in this way were very well tolerated.

However, there were still cases in which improvement could be achieved, but complete relief of symptoms was not possible. In his search for the causes, Haase also applied tests he had devised for cyclophoria and aniseikonia. However, he found unexpected test perceptions, namely deviations in the horizontal and vertical directions, which could be eliminated by means of further prismatic steps. Corresponding eyeglass corrections reduced the symptoms even further. Finally, he also included stereopsis in his observations and found that in a number of cases, only the addition of another – usually quite small – prisms led to full stereopsis, which he regarded as evidence of the achievement of ideal binocular vision.

From all this, Haase concluded that there are pairs of heterophoric eyes that do not fully compensate for their misalignment through muscular effort during natural vision, but instead yield toward the position of misalignment to the extent possible without causing double vision. At that time, studies from the United States by Ogle et al. also pointed in this direction.[6] Even then, there was consensus that there are tolerance ranges, known as "Panum's area", around the retinal points that work together ideally (correspondingly) in both eyes. Such small misalignments without diplopia were already referred at that time to as fixation disparity (FD).

[6] K.N. Ogle, M. Frances, A. de H. Prangen: "Fixation disparity and the fusional processes in binocular single vision", American Journal of Ophthalmology 32(8):1069-1087 (1949)

Further studies have since confirmed Haase's assumption that this condition can lead to a significant loss of quality in binocular vision.[7]

Although FD does not lead to diplopia, Haase concluded that there was an adjustment in the sensory relationship between the two eyes in the form of a change in correspondence. He also noted limitations in binocular vision, including suppression and reduced stereopsis. He therefore considered the slight misalignment present in FD to be in need of correction and determined the prism required to reactivate the originally learned bicentral correspondence in his stereopsis tests.

The sensory adaptations in heterophoria-related FD are a decisive feature that fundamentally distinguishes the theory of MCH from other approaches to heterophoria correction. However, many experts are not yet aware of this or have not yet understood it. Therefore, this idea should be explained again here:

Ogle discovered that fixation disparity can be artificially induced, for example by placing prism glasses in front of an orthophoric test person. He found that above a certain prism load, complete muscular compensation no longer occurs. According to Ogle, the resulting misalignment – the fixation disparity – causes an image position error, which Crone referred to as "retinal slip".[6]

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[7] T.C. Jenkins et al.: "Effect of induced fixation disparity on binocular visual acuity", Ophthal.Physiol.Opt. 12(3): 299-301 (1992)

D. Methling, W. Jaschinski: "Contrast sensitivity after wearing prisms to correct for heterophoria", Ophthal.Physiol. Opt. 16(3): 211-215 (1996)

W. Jaschinski: "Asthenopische Beschwerden und die Konvergenz der Augen am Bildschirmarbeitsplatz: Neue Messverfahren für Praxis und Forschung", Klin Monatsbl Augenheilkd 220(8): 551-558 (2003)

C.I. O'Leary, B.J.W. Evans: "Double masked randomised placebocontrolled trial of the effect of prismatic corrections on rate of reading and the relationship with symptoms", Ophthal.Physiol.Opt.26: 555-565 (2006)

M.L. Conway, J. Thomas, A. Subramanian: "Is the aligning prism measured with the Mallett unit correlated with fusional vergence reserves?", PLoS One 7(8): e42832 (2012)

Since prisms can induce FD, Haase concluded that the strain on the extraocular muscles caused by heterophoria can also lead to FD. This FD can become established and consolidated due to permanent phoric strain. In this case, a retinal point within the central Panum's area is used for fixation in the deviating eye.

Initially, this disparate retinal point is used for fusion while bicentral correspondence still exists. Haase called this state "disparate fusion". Through continuous use of the disparate retinal point, it gradually "unlearns" its original oculocentric direction and assumes the oculocentric direction "straight ahead" in binocular vision. Haase called this condition "disparate correspondence". From the perceptions in the individual tests, Haase drew conclusions about how strongly the sensory adaptations had already solidified.

This concept of heterophoria-induced fixation disparity with accompanying changes in retinal correspondence makes it plausible that even low prismatic values may be necessary to achieve the desired reactivation of bicentral correspondence.

Haase provided a large number of heterophoric patients with prismatic glasses that also corrected the FD. The successes observed with this approach led him to establish the so-called "full correction rule" (MCH measurement value = correction value). With lower prismatic values, he expected a renewed deviation into disparate fixation and the associated reduction of binocular vision.

Haase's ideas convinced many experts, and his working methodology found broad acceptance in ophthalmic optics. Although the concept of "heterophoria-related FD" also found its way into ophthalmological and orthoptic thinking, its clinical relevance (= need for correction) is still controversially discussed today.

The theory of MCH has long been the subject of research. Although the undisputed practical successes of MCH corrections certainly cannot be regarded as scientific proof of their effectiveness, the frequency of these successes and the interests of people with heterophoria-related asthenopia make it essential to continue teaching and applying this method.

1.4 Always correction? Always full correction?

The IVBS aims to promote MCH as the most successful method currently available for determining prismatic corrections.

From the IVBS's current perspective, the term "full correction", which is often associated with MCH, does not imply a dogmatic requirement to fully correct every heterophoria.

Instead, in each individual case, a decision must be made as to whether prismatic correction is likely to be successful, taking into account the measured value and any existing strain symptoms and/or visual disturbances.

If correction is to be carried out, a decision must be made on a case-by-case basis as to

- whether full prismatic correction is necessary to maintain or reactivate bicentral correspondence

or

- whether targeted undercorrection is sufficient to relieve motor strain.

Differentiation of the term MCH

According to the MCH concept, prismatic corrections based on measurements in secondary directions of gaze are not considered.

The publications by H.-J. Haase do not contain any instructions to forgo the prismatic full correction determined in the primary direction in certain cases and instead prescribe the prism that results from secondary directions of gaze. Therefore, such modified procedures should not be referred to as a special type of MCH.

MCH versus vision therapy

In general, all forms of visual training (VT) aim to address and improve specific visual functions. Regardless of the effectiveness of these measures, no exercise or training treatment should be carried out for several weeks prior to an MCH measurement. Any form of vision therapy influences the visual system, which can alter the measurement results of MCH. The independent concepts of MCH and visual therapy must therefore not be mixed.

IVBS recommendation for optometric management of symptomatic heterophoria

- First relieve the strain – through prismatic correction,
- then – if still necessary – apply training.

This means that if heterophoria and visual problems are present at the same time, an attempt at correction with MCH-based eyeglasses should be made *first*.

If the visual problems are not completely eliminated by correcting all image position errors, professionally guided and controlled visual training can be considered *afterwards* in addition to fully corrective eyeglasses.

Possible criteria for applying MCH

A complete correction determination according to MCH naturally requires more time than a simple check of the refraction values.

In practice, however, the question of whether a complete examination is necessary sometimes arises. This can be decided on a case-by-case basis using the following steps:

- **Anamnesis** (see page 32) ➢ criterion: complaints
  Since prismatic correction is usually indicated for symptomatic heterophoria, every patient should be asked about complaints that could be caused by stress in binocular vision.

- **Stereo acuity test** (see page 80)
  ➢ criterion: threshold of stereopsis
  Impaired stereopsis can be a crucial indicator of heterophoria-related FD. Therefore, it should be tested whether there is a threshold of stereopsis outside the norm.

- **Cross test** ➢ criterion: displacement
  Displacement in the cross test indicates motor compensation of heterophoria components. This means that a previously determined ideal stereopsis may only have been achieved after self-compensation of heterophoria by means of the extraocular muscles. For complaints that also affect near vision, the cross test for near vision should also be used.

If symptoms are present and abnormalities are detected for at least one other criterion, a complete correction assessment in accordance with MCH is recommended.

The criteria proposed here only allow for screening for heterophoria. As with any screening, the result may also be a false negative, i.e., an unremarkable result is obtained even though the case requires correction. Each user must decide whether to take this risk or to examine each patient carefully and thoroughly.

1.5 Compatibility of binocular corrections

Many of the historical measurement methods still in use today (e.g., Maddox, Schober, von Graefe) are characterised by a certain degree of uncertainty regarding the handling of the measured values. As a result, there are correction recommendations that differ significantly from one another in some cases.

H.-J. Haase's primary focus was to develop a measurement method that would provide a compatible correction value. To achieve this, he brought the measurement conditions closer to natural vision. In contrast to all traditional methods, fusion stimuli are effective in all heterophoria tests of the MCH, meaning that fusion is not completely eliminated.

Experience has shown that **full correction** determined according to the rules of MCH is usually compatible.

Targeted **undercorrection** (based on the prisms determined in the cross tests for distance and near vision) is also usually compatible and can be considered if the primary goal is motor relief.

Overcorrection would lead to unusual fusional strain and thus impair tolerability. However, overcorrection is ruled out when MCH is appropriately applied.

1.6 Criticism of MCH

Unfortunately, critics often unsettle those affected with various assertions and prejudices, even though these are often unproven or have been refuted for decades.

The criticism, which is often motivated by professional politics, usually comes from experts who have no personal experience with MCH. On the other hand, some people judge purely on a professional basis, who try MCH without bias and, based on their experience, endorse it or even use it regularly and successfully on their patients.

Below are frequently cited points of criticism and statements from the IVBS:

Criticism (1) *"Prism eyeglasses cause heterophoria to become increasingly severe!"*

In cases of severe, uncorrected heterophoria, motor compensation may cause muscular tension in the vergence system over time. Depending on the strength of this fusional tonus, complete relaxation may not occur during heterophoria determination, which is why only a portion of the heterophoria is initially measurable (analogous to the accommodation tonus in hyperopia).

Wearing the prismatic correction determined so far provides relief, allowing further parts of the tonus to relax and thus become measurable retrospectively. Heterophoria does not increase as a result of prismatic correction; the measured values only increase to the extent that the fusional tonus relaxes.

Criticism (2) *"Prism eyeglasses lead to manifest squint/strabismus and possibly even unnecessary eye muscle surgery!"*

Prismatic correction of heterophoria allows the eyes to assume their resting position. In contrast to manifest strabismus, however, there is bicentral imaging. In cases of severe heterophoria, the resting position assumed behind the prism lenses may appear conspicuous. It is technically incorrect to describe this as manifest squint/strabismus.

A study of more than 18,500 people published in Switzerland in 1980 found that heterophoria is greater than 12^{Δ} in only 2.4% of cases.[8]

However, modern lens technologies enable eyeglasses to be worn comfortably even with high prism values (up to approx. 20^{Δ}). In most cases, surgery is therefore not an option.

Criticism (3) *"Treatment according to MCH produces at best a placebo effect!"*

Even most critics don't deny the practical success of MCH corrections. While these successes aren't scientific proof of the specific effectiveness of MCH-based prism eyeglasses, their frequency means it's not appropriate to say they're just a placebo effect. According to a statistical survey, the success rate for headaches/migraines is 98%.[9]

Criticism (4) *"The theoretical model of MCH is incorrect; its results are merely an artefact of the measurement procedure!"*

This criticism is based primarily on a study whose results can, however, be interpreted in favour of MCH.[10]

Nine test subjects were examined to determine whether an eye

[8] K. Günthert: "Heterophorien im Spiegel der Statistik", Der Augenoptiker 12:8-15 (1980)
[9] S. Schmitz: "Kundenbefragung zur Meß- und Korrektionsmethodik nach H.J. Haase (MKH)", ZVA-Schriftenreihe zur Augenoptik, Band 7 (1998)
[10] J. Gerling, H. de Paz, V. Schroth, M. Bach, G. Kommerell: "Ist die Feststellung einer Fixationsdisparation mit der Mess- und Korrektionsmethodik nach H.-J. Haase (MKH) verlässlich?", Klin Monatsbl Augenheilkd 6:401-411 (2000)

movement occurs in the cover test in the case of fixation disparity. However, no real cover test was performed; instead, the fixation object for one eye was simply hidden in the test field. Thus, binocular vision conditions remained unchanged, meaning that the disparate correspondence centre in the FD eye remained active. An eye movement that would shift the image of the fixation point to the centre of the fovea was therefore not to be expected and, did not occur in this experiment. The test results thus correspond to the observation made in the MCH heterophoria tests that, in the case of consolidated FD under binocular vision conditions, there is no shift back of the direction value "straight ahead" to the centre of the fovea.[11]

Several years earlier, a Swiss/Dutch study had already come to the conclusion that a correctly performed cover test triggers an movement in cases of fixation disparity.[12]

Incidentally, strabologist Kommerell now takes a critical view not only of MCH but of all heterophoria measurement methods, as he believes they are performed under artificial visual conditions. He recommends, for example, giving the patient a prism bar to take home so that they can determine their own vergence resting position ("self-selected prism").[13]

Criticism (5) *"The compensatory capacity of the visual system is entirely sufficient to compensate for heterophoria; therefore, prism eyeglasses are unnecessary!"*

In fact, in some cases, heterophoria is self-compensated without causing any discomfort. However, if discomfort occurs, relief should be provided by means of prismatic correction. Permanent compensation of heterophoria requires energy that the system lacks elsewhere, which can lead to asthenopic complaints.[14]

[11] Wissenschaftlicher Beirat der IVBV: "Freiburger Studie bestätigt MKH-Beobachtungen zu alter Fixationsdisparation", DOZ 3:35 (2001)
[12] H.J. Simonsz, L.J. Bour: "Covering one eye in fixation-disparity measurement causes slight movement of fellow eye", Documenta Ophthalomologica 78:141-152 (1991)
[13] G. Kommerell, M. Kromeier, F. Scharff, M. Bach: "Asthenopia, associated phoria, and self-selected prism" Strabismus 23(2):51-65 (2015)
[14] E. Friederichs: "Pestallozzi und die Vision vom Gehirn – Fortsetzung einer Geschichte?", DOZ 3:36-38 (2005)

Criticism (6) *"According to MCH, every heterophoria must be fully corrected using prism eyeglasses!"*

This is also incorrect. For decades, the IVBS has recommended that prismatic corrections should only be prescribed in cases of corresponding discomfort. In each individual case, a decision must be made as to whether full correction or targeted undercorrection is appropriate (see section 1.4).

Criticism (7) *"In MCH, binocular correction is often only determined for distance vision, while near vision is frequently neglected!"*

Unfortunately, this claim is repeatedly made, even in current literature. In fact, the official rules for MCH have also prescribed the use of near vision tests for decades.

Therefore, if heterophoria is determined using Haase's distance vision tests but is not followed up with the corresponding near vision tests, this procedure cannot be described as "MCH".

Although the IVBS has repeatedly pointed this out – including personally to the critics in question – the false statement cited above continues to be spread.

2 Instrumentation

2.1 Examination room

The examination room should be sufficiently well-lit. A simple test allows for a rough assessment of the room lighting:

Look at a test field with optotypes for about two minutes, then look at a bright surface next to the test. If afterimages of the test surface are perceived, the examination room is not sufficiently well-lit.

The standard recommends a minimum illuminance of 600 lux for the examination room.[15] For comparison: an office workstation should be illuminated with at least 500 lux.[16]

Artificial lighting is recommended to ensure consistent lighting conditions.

There should be no objects in the vicinity of the test field that could attract the patient's attention during the measurement. Lights should be positioned so that they do not cause distracting reflections on the test surface.

The patient can observe the tests directly or via a silver-coated mirror. To avoid imaging errors, the vision testing device or mirror must be mounted so that when looking at the centre of the test field, it is always secured to look perpendicular through the trial lenses.

To minimise the influence of accommodation, the test distance should be at least five metres, preferably six metres.

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[15] DIN EN ISO 12665:2018-08 "Licht und Beleuchtung - Grundlegende Begriffe und Kriterien für die Festlegung von Anforderungen an die Beleuchtung"
[16] E DIN EN 12464-1:2019-06 "Licht und Beleuchtung - Beleuchtung von Arbeitsstätten - Teil 1: Arbeitsstätten in Innenräumen"

2.2 Vision testing instruments

A key feature of MCH heterophoria tests is that more or stronger fusion stimuli are presented from test to test in order to gradually approximate the measurement situation to natural viewing conditions during the course of the measurement.

Decades of use of classic Polatest vision testing devices for distance and near vision have proven the following characteristics:

- Size of the test field:
  Approx. 3.6° viewing angle (corresponding to approx. 27 x 27 cm at a test distance of 5 to 6 m and approx. 2 x 2 cm at a test distance of 40 cm).
  To ensure uniform peripheral fusion stimuli for all devices, the area surrounding the test area must be blocked out accordingly for larger displays (Fig. 1). This area must be neutral; background images with 3D motifs lead to a *"significant reduction in the zero-position prism."* [17] Depending on the test distance setting, electronic vision testing devices must automatically adjust the size of the frame and all parts of the test figures.

- Brightness of the test field:
  Recommended luminance according to standard[18]: approx. 200 cd/m²
  (Note: This value applies when using the analysers.)

- Contrast of the test figures: approx. 0.9 (Weber contrast)

- Dark characters in a light background

- Simultaneous presentation of the test parts for both eyes

- Complete extinction of the test components assigned to the other eye so that no residual images (so-called "ghost images") of the test components hidden from one eye are visible

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[17] I. de Wal: "Auswirkungen von Kontrastvariationen des Rahmenfusionsreizes am MKH-Kreuztest", Masterarbeit Beuth Hochschule Berlin (2016)
[18] DIN EN ISO 10938:2017-02 "Augenoptik - Anzeigetafeln für die Sehprüfung - Gedruckt, projiziert und elektronisch"

- Same brightness for both eyes
- Same colour test characters for both eyes (no anaglyph separation)
- Option to quickly switch between the two presentation modes to exchange the visual impressions of the right and left eyes (see p. 39)

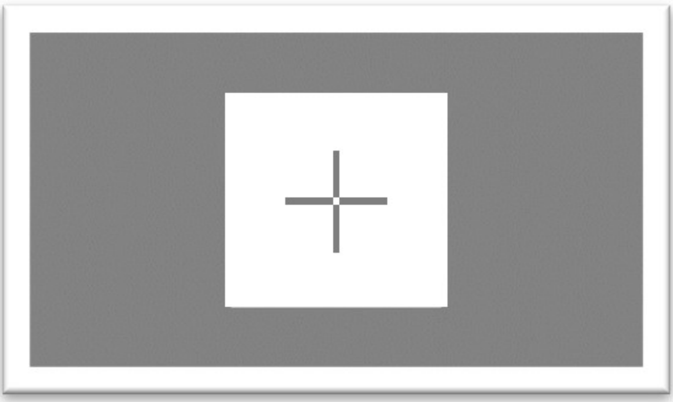

Fig. 1: True-to-size representation of the MCH test field with neutral surroundings on a large display

Performing MCH requires vision testing equipment for distance and near vision, each with the following heterophoria tests:

- Cross test
- Pointer test
- Double pointer test
- Rectangle test
- Stereo delay test
- Stereo dominance test
- Stereo acuity test

2.3 Trial frame versus phoropter

A trial frame with analysers is essential for performing MCH.

If the analysers are not inserted but mounted separately on the trial frame, they must be large enough for use at both near and far distances.

It is also advantageous if both sides of the trial frame are separately height-adjustable.

The forward tilt angle of the trial frame should be selected so that the fixation lines meet the trial frame perpendicularly when looking at the centre of the test field.

Phoropter

A standard, fixed phoropter is unsuitable for performing MCH due to the following disadvantages:

- Changing visual sightlines when moving the head
- Unnatural head and body posture (especially during near vision testing)
- Stimulus for psychological accommodation
- No possibility of letting the patient walk around with the determined correction
- Only prism compensators are available

Prism compensators

Manually adjustable prism compensators are unsuitable for MCH because they do not allow sufficiently accurate adjustment and reading, and the prismatic power can only be changed continuously.

However, very small and gradual prism steps are required for precise prismatic determination in the stereo dominance test (see p. 71).

Furthermore, in cases of horizontal and vertical phoria, prismatic compensators would only allow for a symmetrical distribution of the prismatic power using oblique base positions, which are not recommended for MCH (see p. 38).

Position of the trial lenses in the trial frame

Since the lens manufacturer must be informed of the position of the trial lenses in the trial frame in certain cases, the lens mounts are assigned numbers (Fig. 2).

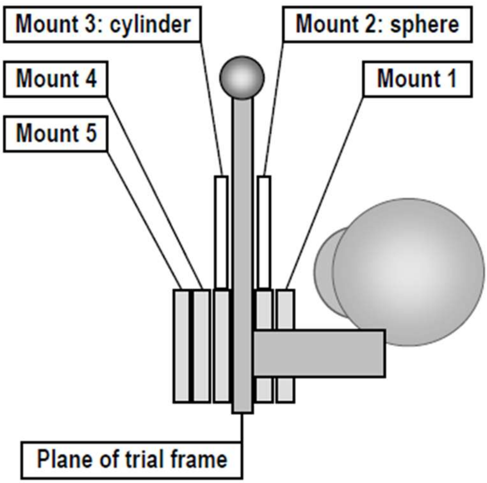

Fig. 2: Numbering of the lens mounts for the trial frame, starting from the eye side, and the optimal position for sphere and cylinder

Graduation of trial lenses

For an efficient procedure, prismatic trial lenses in the following graduation and quantity are recommended:

- up to 2.0^{Δ} in increments of 0.25^{Δ}
- up to 5.0^{Δ} in increments of 0.5^{Δ}
- up to 10.0^{Δ} in increments of 1.0^{Δ}
- above that, any

These trial lenses should be available in pairs and at least in two base settings relative to the position of the handle (Fig. 3). A significant advantage is that each measuring prism can be inserted into the trial frame from above and from the outside, regardless of the required base position.

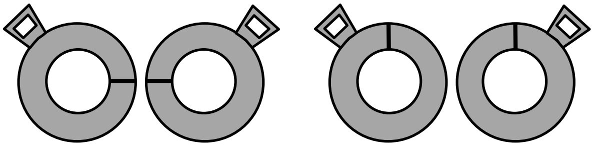

Fig. 3: Prismatic trial lenses with unlike positions of the handle relative to the base position (marked with a line)

To ensure that as few trial lenses as possible are required in the trial frame, the remaining trial lenses should also be available in increments of 0.25 D:

- Spherical trial lenses up to 6 D
- Cylindrical trial lenses up to 4 D

All trial lenses should have a high-quality anti-reflective coating.

The use of prismatic lens bars can also be helpful.

Since it must be ensured that the covered eye is sufficiently excluded from the visual process, a translucent lens (frosted glass) is not suitable. Instead, a matte black cover lens should be used and placed as close to the eye as possible.

3 Centration of spectacle lenses

Successful prismatic correction requires a complete optometric examination and careful implementation of the prescription.

When transferring the values from the trial frame to the corrective glasses, several factors must be considered to ensure that the correction is compatible.

The IVBS recommends maintaining the pupil centre centration (PCC) established during the trial frame fitting throughout the entire correction determination process.

This increases accuracy and also simplifies the process for the practice, as there is no need to change the alignment during heterophoria determination (see exceptions below).

Explanations:

Measuring prisms used in the cross test allow the heterophoric eye pair to deviate toward its resting position. Then, the optical centres of the spherical and cylindrical trial frames are no longer viewed, resulting in a prismatic side effect.

The total prismatic power is then composed of this prismatic side effect and the power of the measuring prisms used. Thus, the measuring prisms used do not represent the magnitude of the heterophoria.

In order for the lens manufacturer to calculate the total prismatic power, it must be specified when ordering the lenses that the PCC was used.

From a power of the prismatic trial lenses of approx. 12^{Δ}, it is advisable to specify further parameters, e.g., the arrangement of the trial lenses in the trial frame with regard to their position and the position of the prism bevel (forward or backwards), as the manufacturer can then calculate the lenses more accurately. For this purpose, it is also necessary to specify the corneal vertex distance (formerly "special case").

Exception 1: When using trial lenses with a glass diameter of 21 mm, a total prismatic power of approx. 24^{Δ} or more may cause a disturbing restriction of the field of vision (vignetting). In this case, the optical centre distance must be changed in the opposite direction to the base position until no more vignetting occurs. When ordering the lenses, the manufacturer is informed of the horizontal and vertical centring values of the trial frames set at the beginning and end of the correction determination.

Exception 2: The pupil centre centration cannot be achieved for anatomical reasons (e.g., wide nose, small pupillary distance).

Apart from these two exceptions, changing the trial frame settings during heterophoria determination is not recommended because the implementation of the so-called "Prism Rule of Thumb" is often inaccurate.[19]

Lack of standards

Unfortunately, there are currently no uniform standards for implementing prismatic corrections among eyeglass lens manufacturers. Ideally, all manufacturers should uniformly use the pupil centre centration as the standard.

If a lens manufacturer requires the order values in formula case format ("adjusted" according to the "Prism Rule of Thumb”), the necessary values can be calculated using a simple application (Fig. 4). This application is available to IVBS members on the IVBS website after logging in.[20]

[19] S. Reiß: "Wie sinnvoll ist der "Formelfall der Brillenglaszentrierung"?", DOZ 7:82-90 (2020)
[20] https://www.ivbs.org/login/

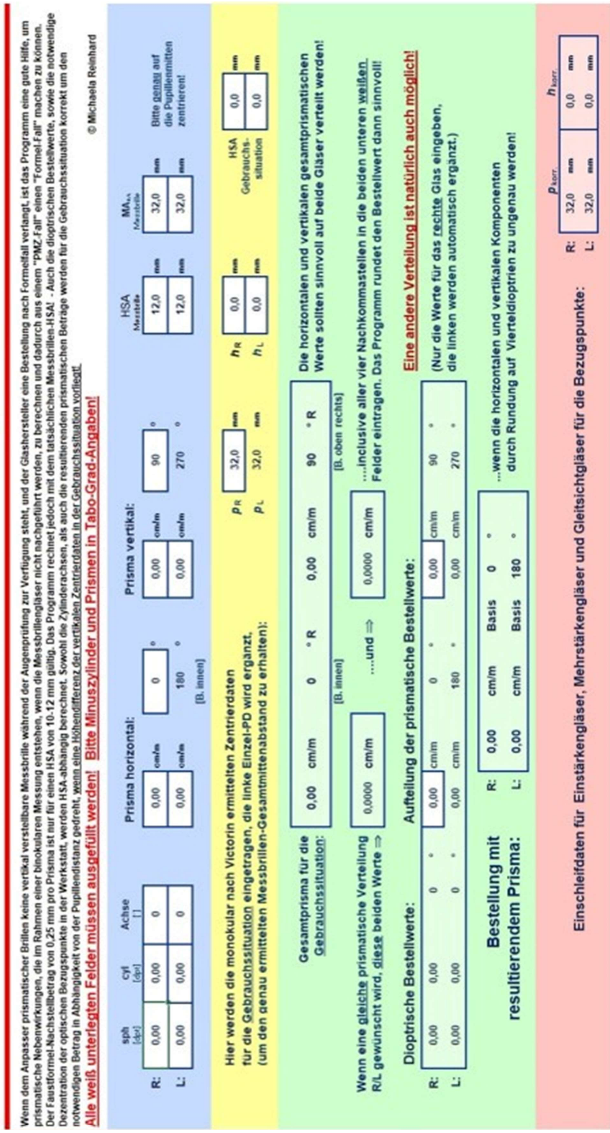

Fig. 4: Input mask for converting PCC prism to formula case prism with example values

4 Documentation

Regardless of the documentation requirements of the respective professional group, certain information must be recorded for MCH.

This is to ensure the following:

1. That the measurement process is traceable, e.g., for checks and consultations. For this purpose, relevant details are recorded:

- Results of medical history and preliminary examinations
- Zero position prism in the cross test
- Total prism after pointer, double pointer and rectangle tests
- Stereo delay, stereo dominance and stereo acuity (each with the corresponding prism)
- Tone relief, diplopia, suppressions, exclusions, results of FD analysis if applicable, difference between distance and near vision if applicable, etc.

2. That the intended dioptric power is achieved in the corrective glasses to be manufactured. The following parameters are documented and, if necessary, forwarded to the lens manufacturer:

- Correction values R/L: sph; cyl, A; pr_{hor}, Base; pr_{vert}, Base; Add; (if applicable: Npr_{hor}, Base; Npr_{vert}, Base)
- Centring data of the trial frame at the beginning of the correction determination: horizontal (C_R, C_L) and, if applicable, height difference (Δy)
- Adjustment of the trial lens at the end of the correction determination (usually PD, see Chapter 3)
- Main working distance (if different: near testing distance)
- Visual acuity (sc and cc: mon. and bin.; for distance and near, respectively)
- Corneal vertex distance (CVD) R/L of trial frame and corrective eyeglasses
- Pantoscopic tilt of the corrective glasses
- Face form angle of the corrective glasses

5 Basic information about determining corrective measures

Determining corrective measures (also called "refraction", "ophthalmic lens determination" or simply "lens determination") is part of an optometric examination, which also serves to check the health of the eye and various visual functions.

A complete correction determination according to MCH always requires anamnesis and preliminary examinations.

This is followed by **refraction determination** (determination of the spherical and cylindrical measurements for each individual eye) and later **heterophoria determination** (determination of the prismatic measurements for both eyes) for distance and proximity.

The final refractive and prismatic correction values are determined based on anamnesis, preliminary examinations, monocular and binocular measurements and testing. If necessary, the corneal vertex distance must be taken into account (and in exceptional cases also the adjustment of the trial frame, see p. 25).

6 MCH procedure

Components of a complete determination of the correction according to MCH, as well as supplementary work steps:

1. **Anamnesis**

2. **Preliminary examinations**
   - Cover test fixation responses
   - Ocular motility
   - Near point of convergence
   - Pupillary reflexes
   - Anterior and posterior segments of the eye (if necessary)

3. **Additional preliminary examinations**
   - Accommodation, vergence (if required)
   - Pursuit and saccades eye movements (if required)

4. **Refractive error determination for distance**
   - Objective
   - Subjective

5. **Optional measurements**
   - Binocular visual acuity
   - Stereo acuity

6. **Determining heterophoria for far distance**

7. **Control of tonus**
   (using the cross test for distance)

8. **Binocular refractive adjustment for far distance**
   - Cylinder axes (if cyl. >1.0 D)
   - Spherical values (if changed: check prismatic values using the cross test for distance vision)

9. **Determining heterophoria for near distance**

   - For presbyopia: with temporary near addition
   - For anisometropia: preliminary examination for accommodation balance
   - Completion: check heterophoria tests for far distance

10. **Refractive error determination for near distance**

   - For presbyopia: final near additions and accommodation balance for the individual's main working distance
   - Near astigmatism (if necessary)

11. **Analysis of fixation disparity**

    (optional; for distance tests)

   - Determination of the subtype of disparate correspondence

12. **Testing**

   of the intended correction under real conditions

   - Determination of the final correction values

13. **Consultation and frame fitting**

   - Explanation of the correction values
   - Frame selection
   - Anatomical and optical frame fitting
   - Lens selection

14. **Lens order and eyeglass production**

15. Eyeglass delivery

   - Individual instructions for use
   - Measures to promote compatibility, if necessary

16. **Follow-up check**

   - For targeted follow-up

7 Anamnesis

Within the scope of MCH, a complete optometric anamnesis is essential, including careful documentation (e.g., using questionnaires).

Substantial criteria:

- Time and type of initial treatment
- Previous ocular and systemic diseases
- Eye surgery, vision therapy
- Drugs, current therapies
- Familial predisposition (e.g., strabismus, severe hyperopia)

In connection with binocular vision, the following asthenopic complaints should be noted in particular:

- Headaches, migraines
- Neck complaints
- Disturbing sensitivity to light
- Rapid fatigue/lack of concentration during demanding visual tasks
- Difficulties changing the direction of gaze and/or viewing distance
- Problems with near vision
- Fixation difficulties
- Instability of the visual perception
- Difficulties estimating distances and speeds
- Occasional diplopia
- Problems with reading and writing, especially in children

8 Preliminary examinations

At least the following tests are performed:

- Cover/uncover test for far and near distance
- Ocular motility test
- NPC test (near point of convergence)
- Pupil reaction test

Abnormalities in the cover test and the ocular motility test are concrete indications of strabismus and require further clarification. In the uncover test, abnormalities indicate heterophoria, but are usually only clearly recognisable in cases of greater heterophoria (an adjustment movement of 0.5 mm corresponds to approx. 4^{Δ}). Abnormalities in the NPC test, on the other hand, can often not be immediately attributed to a specific cause. Nevertheless, it is helpful to check convergence ability, as this allows an assessment of whether problems with progressive lenses are to be expected, among other things.

The results of the pupil reaction test have no direct relation to binocular vision. Nevertheless, the test is part of this procedure plan because it is also considered mandatory in the guidelines of the relevant professional associations.[21]

Since a variety of factors can influence visual perception, further targeted preliminary examinations should be carried out if necessary. This applies in particular to the following areas:

- Eyelids (e.g., incomplete eyelid closure, entropion, ectropion)
- Tear system (e.g., dry/watery eyes)
- Cornea (e.g., dystrophies, irregularities, condition after refractive surgery)
- Iris (e.g., anisocoria, pupil distortion, synechia)
- Eye lens (e.g., cataract, multifocal IOL, posterior capsule opacification)
- Vitreous body (e.g., floaters, opacities)
- Retina (e.g., oedema, AMD, occlusive diseases)

See also "Important information about preliminary examinations" on page 34.

[21] Zentralverband der Augenoptiker und Optometristen: "Arbeits- und Qualitätsrichtlinien für Augenoptik und Optometrie", 10. Auflage (2024)

9 Additional preliminary examinations

Depending on the results of anamnesis and previous tests, additional examinations are carried out if required. Here are a few examples:

- Checking accommodation (e.g., accommodative amplitude, accommodation accuracy, accommodation flexibility, relative accommodation)
- Assessment of the coupling of accommodation and vergence (e.g., using dynamic retinoscopy, AC/A measurement)
- Checking of pursuit and saccadic eye movements with special tests (in addition to the ocular motility test)

Important information about preliminary examinations

- For all preliminary examinations, it must be decided whether they should be performed with or without the correction worn to date. Example: Ocular motility test without correction, among other things, so that the frame edges do not have a limiting effect and do not interfere with the observation.
- If the newly determined correction differs from the one previously worn, the results of the preliminary examinations may have to be evaluated differently. For example, uncorrected hyperopia can simulate accommodation insufficiency.
- For more detailed information on all preliminary examinations mentioned in chapters 8 and 9 and on the evaluation of the results, please refer to the relevant specialist literature.
- Additional interdisciplinary investigations should be recommended in particular if there are disorders that may have causes other than ocular ones (e.g., neurological investigation in the case of sudden onset of diplopia).

10 Refractive error determination for far distance

In the presence of heterophoria—according to consistent data in the specialist literature, this affects 70 to 80% of the population—it is essential to first determine the refractive values (sphere and cylinder) under monocular conditions. Reason: Accommodation and vergence are linked, but the binocular status is usually not yet known at the beginning of the lens prescription process.

Distinction

Without a cover disk, the above-mentioned link could cause an exophoric patient, for example, to assume too much minus power in order to compensate for their heterophoria through accommodative convergence. Thus, under binocular vision conditions, there is neither a resting position of accommodation nor a resting position of convergence. However, both are prerequisites for reliable correction determination.

Here are further examples of cases in which "monocular refraction under binocular conditions" can be problematic: Patients with alternating vision, severe visual suppression, fusion problems due to aniseikonia or amblyopia. Therefore, not only in such exceptional cases, but as a general rule: *"Objective and/or subjective refraction determination under monocular conditions"* (quote from the ZVA working guidelines).[Fehler! Textmarke nicht definiert.]

For these technical reasons, MCH also differs from the concept of so-called "3D refraction", which involves performing refraction determination in binocular vision.

Final criterion for spherical fine determination

Successive, monocular adjustment using the smallest possible high-contrast optotypes (black in a light background). Under no circumstances should a red-green test be used because the colour longitudinal error of the eye in this test can trigger an uncontrollable influence on accommodation.

Immediately after the monocular refraction assessment of both eyes, no binocular refractive adjustment is performed (see p. 86).

11 Optional measurements

To record the initial binocular situation, it may be useful to measure specific visual performance parameters before the application of prismatic trial lenses potentially alters these.

Binocular visual acuity

With ideal binocular vision, binocular visual acuity is always higher (by approximately one visual acuity level) than the visual acuity of the individual eyes due to binocular summation. However, this is not the case with FD-related visual impairments. It is already considered remarkable if the binocular visual acuity only corresponds to the monocular values.

> *Example: Monocular visual acuity on both sides is 1.25; binocular visual acuity is 1.25. Ideally, a value of 1.6 would be expected here. In individual cases, possible imaging errors of stronger prismatic values must be taken into account.*

If the binocular visual acuity values with and without prismatic correction are to be compared, it is essential to measure them before determining heterophoria. Reason: Visual inhibitions can often be resolved during the course of heterophoria determination.

Stereo acuity

For similar reasons, stereo acuity should also be measured *before* determining heterophoria. After reactivation of bicentral correspondence and resolution of all visual inhibitions, a difference in stereo visual acuity with and without prisms would no longer be expected.

The stereo acuity test is used for the determination. Since this is being presented here for the first time, it should first be explained to the patient (see p. 79).

The minimum stereo angle serves as a measure of stereo acuity. Instructions for its determination can be found on pages 81-82.

12 Determining heterophoria for far distance

A complete determination of heterophoria must include both motor compensation and all types of sensory adaptation to heterophoria. This requires three different types of tests: a conventional heterophoria test, classic FD tests (with a central fusion object to detect less established sensory adaptations) and stereopsis tests (to detect more established sensory adaptations).[22] (see p. 7)

Therefore, procedures in which heterophoria is determined exclusively using classic FD tests should be viewed critically. Due to the central fusion object contained therein, motorically compensated heterophoria components can only be determined to a limited extent or with greater time required. However, it is important to determine these components, as muscular compensation may be responsible for strain-related symptoms. Therefore, heterophoria determination according to MCH must begin with the cross test, i.e., a conventional heterophoria test.

It is also important to continue the heterophoria determination with stereopsis tests following the classic FD tests. This is the only way to determine FD components with disparate correspondence, in which the change in the directional value has already spread to the retinal periphery.

A prerequisite for a correct heterophoria determination result is full refractive correction for both individual eyes.

Before starting the heterophoria determination, all refraction data (including visual acuity and trial frame settings) should be noted so that, for example, accidental twisting of the cylinder axes can be corrected quickly and easily.

To quickly reorient oneself at follow-up appointments and estimate the time required, it is recommended to document the procedure for heterophoria testing.

Optionally, the heterophoria tests can be presented at the beginning without the use of measuring prisms. Such a zero run

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[22] H. Goersch: "Die drei notwendigen Testarten zur vollständigen Heterophoriebestimmung", Deutsche Optikerzeitung 11:6-16 (1987)

serves to distinguish between motor compensation and disparate fusion (FD I).

When determining heterophoria, it is particularly important to convey to the patient that their answers, even if expressed uncertainly, are always correct and important, and that their vision problems are understood.

If the patient has difficulty describing their visual impressions, aids can be used to indicate test perception, e.g., movable miniature images of the tests.

Since overcorrection should be avoided at every stage of heterophoria determination, smaller prism steps should be taken in case of doubt. Overcorrection would trigger fusion in an unfamiliar direction and could even distort the result.

Order of tests

The tests are initially performed in the following order: cross test, pointer test, double pointer test, rectangle test, stereo delay test, stereo dominance test, stereo acuity test.

It may be useful to deviate from this order, e.g., to check how a measurement step affects one of the other tests.

Prism distribution

The prismatic power should be distributed as evenly as possible between both eyes in order to minimise the imaging errors of prismatic trial lenses.

Oblique base positions

These are not recommended because they do not allow horizontal and vertical prisms to be changed independently of each other. It is also not recommended to create a vertical prismatic effect by rotating horizontal prisms, for example, because this would weaken the horizontal prismatic effect.

Possible risks of oblique base curves:

- Inaccurate reading of the base curve due to parallax error
- Rotation of the cylinder axes when turning the prisms

Types of presentation

In all heterophoria tests, the right and left eyes are each presented with specific partial images. For each test, a specific assignment is defined as "converse presentation" and one as "inverse presentation", with the assignment of the partial images being reversed in each case.

It is not sufficient to achieve ideal perception for only one type of presentation. Rather, this should be aimed for in both presentation types in almost all heterophoria tests. Converse and inverse presentation, therefore, have absolutely equal priority.

Since the term "normal presentation" has often led to the misunderstanding that this presentation type is a priority, it has been renamed "converse presentation".

12.1 Fundamentals of cross tests and classic FD tests

The classic FD tests of MCH (pointer test, double pointer test, and rectangle test) indicate FD based on the direction values at the respective image locations. The MCH stereopsis tests determine additional FD components, but according to different criteria (see Chapter 12.6).

Contrast differences

Both the cross test and, if necessary, the rectangle test check for contrast equality between the test components for the right and left eye.

Contrast equality is usually evidence of refractive balance, occasionally even in cases of unilateral amblyopia.

Contrast differences in heterophoria tests may be caused by FD-related visual inhibitions, but may also have other causes, e.g., unilateral cataracts or refractive imbalance.

In particular, it cannot be clarified whether inhibition phenomena in binocular tests also exist in natural vision. Rather, the projection of different images onto areas of the retina that always receive the same images in both eyes during free vision provokes the occurrence of binocular competition and thus visual inhibitions.

If contrast differences still exist at the end of the cross test and/or rectangle test, the control of tonus and FD analysis is used to determine whether contrast equality has been established in the further course of the heterophoria determination. In this case, it can be concluded that the contrast differences were caused by FD-related inhibitions.

In contrast to the cross test and the rectangle test, the image components in the pointer and double pointer tests are projected onto unequal retinal locations in both eyes (scales further peripheral than the pointer). Therefore, no contrast equality test is performed in these two tests.

If contrast differences remain at the end of the heterophoria determination in the distance tests, a distance cross test is used to check whether the cause lies in a refractive imbalance.

Other possible causes of contrast differences include the following:

- Different numbers of trial lenses in front of both eyes
- Deviations from the physiological ideal state of the eyes

Covering the eye that sees "blacker" alone does not allow for a reliable determination of the cause, as the resulting improvement in contrast may be due to either more precise accommodation or more accurate fixation.

If stable simultaneous vision and contrast equality are present in the cross test, contrast equality no longer needs to be checked in the rectangle test.

Contradictory perceptions

- Opposing phoria readings with different tests with the same presentation type (e.g., exo-perception at the cross test and eso-perception at the pointer test):
  - Try increasing the prism
  - Try decreasing the prism
  - Change the presentation type

- Opposite perceptions at the same test with both presentation types (greater exo-perception in converse presentation than in inverse presentation at the pointer test):
  - Try increasing the prism
  - Try weakening the prism

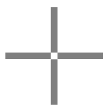
- Parallel but differently sized phoria indications in the same test in both presentation types (e.g., greater exo-perception in converse presentation than in inverse presentation at the pointer test):
  - First, compensate for the greater deviation
  - Then check in the other presentation type

If contradictory perceptions cannot be eliminated, the heterophoria determination is continued in further tests. These contradictions often no longer exist with full prismatic correction.

12.2 Cross test

DE: Kreuztest

Abbreviation: C

	In converse presentation, the vertical bar (with a central gap) is assigned to the right eye, and the horizontal bar (with a central gap) is assigned to the left eye. In inverse presentation, the assignment is reversed.

Intended use

- Prismatic compensation of motor-compensated heterophoria components and/or disparate fusion (FD I)
- For binocular refractive adjustment: establishing refractive balance

Test explanation and application

For a better understanding, start by presenting the symmetrical cross monocularly without analysers (with an occluder over one eye).

Then place the analysers in front.

Sample question:

"*What remains of the cross?*"

The choice of words in the answer is helpful for further questioning techniques (examples: horizontal, flat, lying down – dash, bar, line, minus sign). The term chosen by the patient should be used further.

Now remove the occluder.

All objects viewed with both eyes trigger a central fusion stimulus that initiates motor fusion. To ensure optimal relaxation of motor function during the cross-test, the eyes should not fixate on objects that can be fused. Therefore, ask the patient (repeatedly if necessary):

"Please only look at the centre of the test field."

Question criteria

1. Simultaneity and completeness (simultaneous vision)
2. Contrast equality (colloquially "blackness equality")
3. Position and image stability (symmetry)

For 1: To be able to indicate test misalignments reliably, the patient should see the cross bars for the right and left eyes simultaneously and completely. Therefore, the first step is to check for absolute inhibitions (exclusions).

For 2: To be able to track changes in perceived contrast differences during the course of heterophoria determination, the patient is asked whether the two cross bars are perceived as having equal contrast ("equally black"). Contrast differences can indicate relative inhibitions (suppressions).

For 3: To determine the direction of heterophoria, the position of the two cross bars in relation to each other is asked. The perception of the test position results from the directional values of the image locations in both eyes.

Assessment difficulties

If the cross bars appear unstable or are only seen alternately in the initially selected presentation mode, it is checked whether the patient can provide better information on displacements (more stable perception) in the other presentation mode. The measurement is then started in this presentation mode.

Perception in the near cross test

Before the first prism step in the distance cross test, perception can be tested in the near cross test, before any possible influences from the distance prisms have occurred.

To do this, switch briefly to the near vision tester and test perception in the near cross test without prismatically compensating for any described displacement. In the case of presbyopia, this test is performed with a temporary near addition. Once the examiner knows the initial situation for near vision, he begins determining heterophoria for distance vision.

This test is optional, but it can provide additional information for assessing the interaction of accommodation and vergence. If the distance prisms improve visual function, improved perception is expected later in the near cross test. If, on the other hand, it has deteriorated, this is an essential indication that further examinations should be carried out (see Chapter 9). Figure 5 shows two example cases; further practical examples are described from page 98 onwards in the chapter on determining heterophoria for near vision.

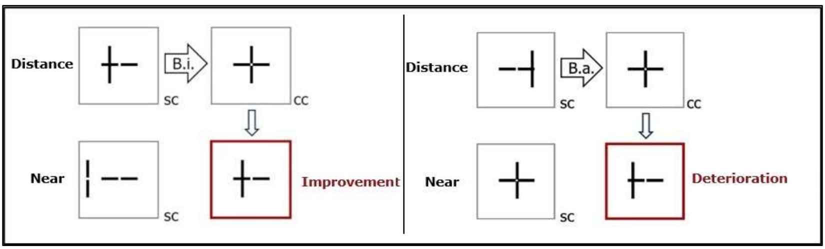


Fig. 5: Practical examples of altered perceptions in the cross test for near vision

In both cases shown in Figure 5, there is zero position perception at the far test$_{cc}$ and exo-perception at the near test. Only based on the previously recorded perception$_{sc}$ can it be seen that the prisms for distance vision led to an improvement in one case and a deterioration in the other case in the near cross test.

Size of the first prism step

- Horizontal 1.0$^{\Delta}$
- Vertical 0.5$^{\Delta}$

The size of the next prism step depends on the effect of the previous step.

If there is a difference between horizontal and vertical displacement, the larger of the two should be corrected first until both displacements are approximately equal. Then reduce the displacement in both directions in small steps.

During follow-up examinations, a starting value that is slightly lower than the last prism value worn should be inserted into the trial frame.

Release of tonus

Allow plenty of time for the cross test so that any fusional tonus that may exist can be released as completely as possible.

If tonus relaxation is only hesitant, the following measures may be helpful:

- Repeatedly changing the presentation type in the stereo delay test
- Alternate presentation of the cross test for distance and near vision (with near addition for presbyopia) several times

The relaxation of fusional tonus can also be supported by one or more interruptions of the measurement (of approximately 10 minutes). The patient should use the values determined up to that point.

If, in the further course of the heterophoria determination, it is suspected that fusional tonus has been released, the cross test can be returned to at any time, as motor-compensated heterophoria components can be balanced more quickly and reliably there. The heterophoria determination is then continued using the previously used test.

Desired test perception

This is the ideal case: Stable zero position (symmetry) with the weakest prism in both types of presentation.

If this is not achieved, the weakest prism remains in the trial frame, with which the slightest deviation from the zero position is perceived.

In the case of unstable perception, the aim is to achieve an equally wide, equally frequent and equally long fluctuation or jumping of the unstable crossbar around the zero position.

Record keeping

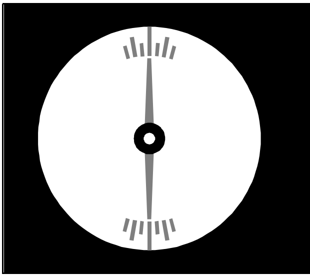
It is important to record the prismatic power determined in the cross test because, depending on the further course of the heterophoria determination, it may be necessary to refer back to this value.

If the measurement is interrupted, e.g., due to patient fatigue or unclear *sensory* conditions, *motor* relief may still be indicated: If exertion complaints persist, check whether the cross test prism is compatible for distance and near vision. If necessary, this value is adjusted in the near cross test, and ad most the prism determined in both cross tests is prescribed.

12.3 Pointer test

DE: Zeigertest (vormals: Zyklophorietest)

Abbreviation: P



In converse presentation, both pointers are assigned to the right eye, both scales to the left eye, while the central circle (and the black background) is presented to both eyes. In inverse presentation, the assignment is reversed.

Intended use

- Prismatic compensation of the horizontal component of the first subtype of disparate correspondence (FD II/1) and motorically compensated heterophoria components that had not yet relaxed in the cross test.

Test explanation and application

Since the description of test perception is simpler in the pointer test, this is usually applied before the double pointer test.

Present the pointer test monocularly, i.e., briefly present the test portion to each eye in succession.

Example wording:

"You see a circle in the middle and a scale at the top and a scale at the bottom."

And accordingly:

"You see the circle again in the middle and a pointer pointing up and a pointer pointing down."

Then ask whether both pointers and both scales are seen at the same time.

Practical tip: If there are still inhibitions with the zero-position prism in the cross test, first choose the presentation method in which the deviating eye sees the pointers. Reason: With the more visually demanding scales, perception problems may occur with this eye.

The pointer positions are queried individually for above and below.

Example question:

"Does the upper pointer point to the middle of its scale, or to the right or left?"

The pointer test should be used in both presentation modes.

Reason: If the change in the directional values in the case of disparate correspondence has just occurred up to the image locations of the pointer tips, a displacement perception will only occur if the scales are displayed in the deviating eye.

Size of prism steps

- 0.25^{Δ}
- If there is no reaction, 0.5^{Δ}

From an increase of approximately one prism dioptre in the pointer test, it is advisable to switch back to the cross test to check whether the motor components have relaxed and to compensate for them there.

Once the best possible test perception has been achieved, the patient is asked whether he can still assess the pointer positions when looking at the circle. If so, and if new deviations occur, these are also compensated for prismatically.

Notes on fixation objects in FD tests

Since FD tests conceptually contain a central fusion object, according to theory, this object must be looked at directly (fixed) for the central fusion stimulus to be fully effective. However, the test details to be assessed (e.g., pointer tip/scale) are projected onto paracentral retinal locations and are therefore relatively far away from the central fusion object (circle).

Since details to be assessed are always looked at directly in natural vision, many patients are unable to determine the test details if they are required to fixate on the central fusion object at the same time.

To avoid unsettling the patient with excessive demands, the FD tests of the MCH do not initially require the patient to look at the circle. In the further course of the test, the perception when looking at the circle is additionally queried, and deviations are prismatically compensated.

In any case, the circle represents a strong fusion stimulus, even if it is not looked at.

Desired test perception

Ideally, with the weakest prism, both pointer tips should point to the centre of the corresponding scale in both presentation modes.

If this is not achieved, the weakest prism remains in the trial frame, with which the slightest deviation from the zero position is perceived. This does not automatically mean symmetry; for example, with the best possible prism value, the upper pointer is perceived in the centre and the lower pointer slightly to the right.

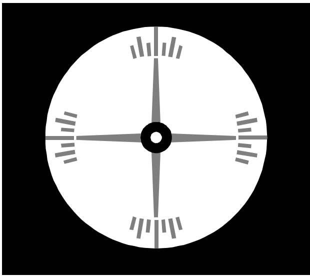
Horizontal pointer test

Optionally, the horizontal pointer test included in some vision testing devices can be used to compensate for vertical components.
Note: This test was developed solely for technical reasons. The first generation of the electronic Polatest device had a relatively small display (around 40% lower test field height compared to the mechanical reference device), which severely limited the use of the rectangle test.

12.4 Double pointer test

DE: Doppelzeigertest

Abbreviation: DP



In converse presentation, all four pointers are assigned to the right eye and all four scales to the left eye, while the central circle (and the black background) is presented to both eyes. In inverse presentation, the assignment is reversed.

Intended use

- Prismatic compensation of the horizontal and vertical components of the first subtype of disparate correspondence (FD II/1), as well as motorically compensated heterophoria components that had not yet relaxed.

- Distinguishing between cyclophoria and anamorphic image distortion.

Test explanation and application

The double pointer test can also be used in both presentation modes. The rationale is the same as for the pointer test (see p. 48).

If the pointer test has been used previously, the double pointer test does not need to be presented monocularly. It is sufficient to point out the additional pointers and scales on the right and left.

Sample question:

"Do you now see an additional right and left pointer with the corresponding scales?"

The four pointer positions are queried individually; the order is arbitrary.

Size of prism steps

- 0.25^{Δ}
- If there is no reaction, 0.5^{Δ}

From an amplification of approximately one prism dioptre in the double pointer test, it is advisable to switch back to the cross test to check whether the motor components have relaxed and to compensate for them there.

Once the best possible test perception has been achieved, the patient is asked whether they can still assess the pointer positions when looking at the circle. If so, and if new deviations occur, these are also compensated for prismatically.

Cyclophoria or anamorphic image distortion?

Cyclophoria and anamorphic image distortion can be distinguished as follows:

- Cyclophoria: All four pointers are rotated by the same amount in the same direction.
- Anamorphic image distortion: There is no right angle between the pointers (due to meridionally different image scales in cases of high oblique astigmatism).

No prism steps can be derived from this, but it improves understanding of the patient's visual situation.

Desired test perception

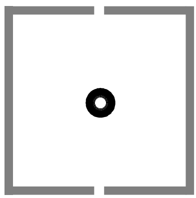
Ideally, with the weakest prism, all four pointer tips should point to the centre of the corresponding scale in both types of presentation.

If this is not achieved, the weakest prism remains in the trial frame, with which the slightest deviation from the zero position is perceived. This does not automatically mean symmetry; for example, with the best possible prism value, three pointers are perceived centrally, and one is slightly shifted.

12.5 Rectangle test

DE: Hakentest (vormals: Aniseikonietest, Rechtecktest senkrecht)

Abbreviation: R

	In converse presentation, the right half of the rectangle is assigned to the right eye and the left half of the rectangle to the left eye, while the central circle is presented to both eyes. In the inverse presentation, the assignment is reversed.

Intended use

- Prismatic compensation of the vertical component of the first subtype of disparate correspondence (FD II/1) and motorically compensated heterophoria components that had not yet relaxed.
- Recognition of vertical aniseikonia and estimation of its size. One bar width corresponds to a difference of approximately 4%.

Test explanation and application

Present the rectangle test monocularly.

Sample wording:

"You will see half a rectangle on the right/left."

Then ask whether both halves of the rectangle are seen at the same time.

Since the halves of the rectangles are projected onto equivalent areas of the retina in both eyes, only one presentation type needs to be measured here. First, check which presentation type is more suitable for this. To do this, ask whether a gap is seen between the two halves of the rectangle at the top and bottom or whether the two halves merge into each other.

If the gaps are not perceived consistently, the presentation type should be changed first. If this does not solve the problem, the fixation circle should be viewed intently.

If the gaps are not consistently recognised in any presentation type, no prism steps may be performed in the rectangle test.

If contrast differences still exist in the cross test, the patient is then asked about the contrast equality of the rectangle halves (see section 12.1).

The position of the two halves in relation to each other is queried individually for the top and bottom.

Particularly in cases where the rectangle halves are perceived as being of unequal size (aniseikonia), an attempt is made to achieve vertical symmetry perception using height prisms.

Size of prism steps

- 0.25^{Δ}
- If there is no reaction, 0.5^{Δ}

From an increase of approximately one prism dioptre in the retangle test, it is advisable to switch back to the cross test to check whether the motor components have relaxed and to compensate for them there.

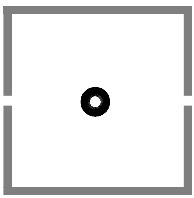
Once the best possible test perception has been achieved, the patient is asked whether they can still assess the rectangle positions when looking at the circle. If so, and if new deviations occur, these are also compensated for prismatically.

Target test perception

Ideally, with the weakest prism in a presentation type, both halves of the rectangle should be exactly opposite each other.

If this is not achieved, the weakest prism remains in the trial frame, with which the slightest deviation from the zero position is perceived.

Horizontal rectangle test

	In converse presentation, the upper half of the rectangle is assigned to the right eye and the lower half of the rectangle to the left eye, while the central circle is presented to both eyes. In inverse presentation, the assignment is reversed.

This test triggers unnatural fusion stimuli (vertically acting orthofugal stimuli). Therefore, it should not be used to measure horizontal heterophoria components. However, it can be used to assess horizontal aniseikonia.

12.6 Basic information about stereopsis testing

A unique feature of MCH is that it derives prismatic measurement steps from stereopsis testing based on limited stereopsis.

Stereopsis (stereoscopic vision, 3D vision) refers to spatial perception based exclusively on the different lateral disparity of retinal image positions. Spatial perception based on monocularly perceptible phenomena (e.g., object overlapping) is therefore not part of stereopsis.

Stereopsis consists of two components:

- Lateraly disparate depth perception
- Lateraly disparate directional vision

In MCH, these two components are tested separately in different tests.

The sensory processing of lateral-disparate image position can be impaired by fixation disparity (FD). FD occurs to reduce the motor fusion effort required due to heterophoria. However, this is accompanied by a misuse of the panum areas, e.g., the temporal part in the case of exo-FD. Thus, in the case of exo-FD, temporally lateral-disparate stereo objects lead to greater stereopsis problems than nasally lateral-disparate stereo objects.

When the eyes are adjusted to the test distance, the converse presentation of stereopsis tests provides a temporally disparate image of the stereo figures (perception towards the front). In contrast, the inverse presentation provides a nasally disparate image (perception towards the back).

In this context, "forward" means stereo figures in front of the test plane and thus closer to the viewer (proximal). Correspondingly, "backwards" means stereo figures behind the test plane and thus further away from the viewer (distal).

Prism steps in stereopsis testing are only possible if information about perception is available in both types of presentation.

Therefore, every MCH stereopsis test must be applied in both converse and inverse presentation.

In MCH, the quality of stereopsis is assessed using various criteria:

- Spontaneity of stereopsis (using the stereo delay test)
- Stereo vision balance (using the stereo dominance test)
- Stereo threshold angle (using the stereo acuity test)

Problematic test perceptions

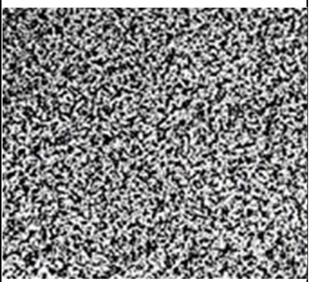
- If stereopsis is not present, the following causes with varying prognoses may be considered:

    - Stereopsis not learned in the sensitive phase
    - Strabismus, microstrabismus
    - Amblyopia
    - Unilateral eye diseases
    - Anisometropia, aniseikonia
    - Consolidated disparate correspondence

    In the latter case in particular, prismatic correction can restore stereoscopic vision.

- Restricted panum areas can cause diplopia of image parts in stereopsis tests. This cause is considered confirmed if diplopia no longer occurs in tests with smaller stereo angles.

Random dot tests



Stereopsis test with randomly distributed dots (random dots) in which stereo figures are hidden without providing contours that are recognisable to the monocular eye. The dots belonging to the stereo figures are presented to the right and left eyes with a lateral disparity.

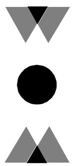
In addition to the stereopsis tests of MCH, random dot tests or other stereo images can be used to demonstrate improvements in binocular vision. These are not necessary to determine the prismatic correction.

If microstrabismus is suspected, a random dot test can be used in addition to other tests, but this does not allow for a definitive diagnosis.

12.7 Stereo delay test

DE: Stereo-Verzögerungstest (vormals: Stereotest, Stereo-Dreiecktest, Dreiecktest)

Abbreviation: SD

	In converse presentation, the two left triangles are assigned to the right eye and the two right triangles to the left eye, while the central point is presented to both eyes. In inverse presentation, the assignment of the triangles is reversed.

Terms

- **Stereo delay**

  A collective term for primary delay and secondary delay.

- **Primary delay (formerly: spontaneous delay)**

  Delayed perception of the spatial arrangement of stereo figures ("triangles forward" or "triangles backwards").

- **Secondary delay (formerly: post-delay)**

  Delayed perception of the final, greater spatial depth of stereo figures ("sliding" of the triangles).

- **Alternating test**

  Alternating between both types of presentation to test for stereo delay.

Intended use

- Prismatic compensation of the second subtype of disparate correspondence (FD II/2) and motorically compensated heterophoria components that had not yet relaxed.

- Clarification of the following questions:
  - Is depth perception present in this test?
  - Is there a correct spatial assignment of the triangles in both presentation types (in converse presentation in front of the fixation point and in inverse presentation behind it)?
  - Is there a stereo delay?
  - Optional: Is the individually optimal stereo depth achieved?

Implementation forms

The stereo delay test is available with different stereo angles.

Standard: Stereo angle 12.5' (corresponds to 20 mm stereo parallax at a test distance of 5.5 m)

If this standard version was not used, the stereo angle (or stereo parallax at the test distance) used for testing must be documented.

Test explanation and application

The stereo delay test is initially presented without any reference to spatial depth. The patient is asked to describe their visual impression in both presentation modes.

In the further course of the test, attention is paid to whether one of the following cases exists:

Case 1: Depth perception with temporal delay

Case 2: No depth perception

Case 3: Diplopia of the triangles or the dot

Case 4: Depth perception with incorrect spatial assignment

<u>For case 1</u> (delay):

The stereo delay test is always performed in two steps: primary delay and secondary delay.

First, multiple change tests are performed to check whether the triangles are displayed immediately after changing the presentation type to the front or rear (primary delay test).

Before changing the prism, it must be checked whether repeated change tests reduce or even eliminate the primary delay. Rule of thumb: If there is no improvement after about ten change tests, a first tentative prism step is taken.

Reason: Full correction may already be present, but remaining visual inhibitions prevent the spontaneous development of depth perception. Repeated change tests can resolve these inhibitions. In such a case, premature increasing of the prismatic power would have led to overcorrection.

In addition, frequent change tests are intended to prevent an improvement in stereopsis from being simulated by a learning effect.

Subsequently, it is checked whether the stereoscopic depth increases during prolonged viewing (check for secondary delay). In this case, too, the alternating test must be performed several times before changing the prism (reason: see above).

In practice, the situation is usually straightforward:

When switching to the stereo delay test, prism lenses are often already in the trial frame, which were determined in the previous tests.

Then, as a simplifying rule of thumb, the prismatic power should first be increased on a trial basis (see initial situation A in Table 1).

The table also contains rules for cases where no prisms have yet been determined (initial situation B).

Table 1: Stereo rules for the stereo delay test

Initial situation		Stereo delay	Trial measure
A	Prisms are already in the trial frame	In only one type of presentation	Increase the horizontal prism*
		In both types of presentation, but of different sizes	
		In both types of performance and of equal size	Increase the vertical prism*
B	No prisms in the trial frame yet	Larger with converse presentation (triangles at the front)	Check with prism base in
		Larger with inverse presentation (triangles at the back)	Check with prism base out
		Equally large in both types of presentation	Check with prism base up or down

**Exceptions:*

- *Stereo delay in only one type of presentation or in both types of presentation, but different; however, only the vertical prism has been determined so far. Then test with a horizontal prism according to initial situation B.*

- *Identical delay in both types of presentation, but only the horizontal prism has been determined so far. Then test with a vertical prism on a trial basis.*

The rules for initial situation B only apply if the patient looks at the fixation point; otherwise, in the case of "incorrect" fixation, the rules are reversed. The patient should therefore be instructed accordingly.

Examples of stereo rules:

1. Prisms in the trial frame: Vertical base position
   Stereo delay: Same in both types of presentation
   Action: Try increasing the vertical prism

2. Prisms in the trial frame: Vertical base position
   Stereo delay: Only in converse presentation*
   Action: Test with base in

   *Considerations: The existing stereo delay indicates an uncorrected horizontal component. Increasing the existing vertical prism is therefore not an option. Since there are no horizontal prisms in the trial frame yet, use initial situation B as a guide.

The following applies to the stereo rules: Repeated stereo alternation tests are used to check whether the respective prism step has led to a reduction in stereo delay.

If the stereo delay has been reduced but not yet eliminated by a prism used on a trial basis, the next prism step must be determined in accordance with the stereo rules (Table 1).

> *Example: Initially, stereo delays of equal magnitude are used in both types of presentation. After adjustment with a vertical prism: Stereo delay only in one type of presentation; now test with a horizontal prism on a trial basis.*

If stereo delays cannot be eliminated or at least reduced by the measures taken so far, the remaining errors are also checked with the other base positions. The effects of corresponding prism steps are also checked using repeated stereo alternation tests.

Sequence of prism steps

- Size of the first prism step: 0.25^{Δ}

Use the respective measuring prism on a trial basis, but only leave it in the trial frame if there is a lasting improvement. Otherwise, *remove* it and proceed in the same way with the next strongest measuring prism.

Reason: A measuring prism that does not bring about any improvement must be removed again, as otherwise there is a risk of overcorrection. In contrast to tests in which overcorrection can lead to misperception in the opposite direction, no clear perception of overcorrection is to be expected in stereopsis tests.

With the first measuring prism used on a trial basis, if the stereo delay

- is eliminated:
  Leave at 0.25^{Δ} and exit the stereo delay test
- is reduced:
  Leave 0.25^{Δ} and additionally use 0.25^{Δ} on a trial basis* (if necessary, with a different base position; see last example)
- is neither eliminated nor reduced:
  Remove 0.25^{Δ} and use 0.5^{Δ} on a trial basis* (with the same base position)

**If necessary, take further prism steps in increments of 0.25^{Δ} (based on experience, up to approx. 1.0^{Δ}). If the release of tonus is suspected, these motor components should first be compensated for in the cross test. The measurement is then continued in the stereo delay test.*

Test criterion

A prism used on a trial basis may only remain in the trial frame if it has a positive effect on the stereo delay. The perception of greater spatial depth is not a test criterion.

Similarly, no prism change may be made based on differently perceived stereo depths to the front and the back.

In principle, the following applies:

A prismatic change is only left in the trial frame if the stereo delay has been eliminated or clearly reduced.

Desired test perception

Immediate depth perception in both types of presentation.

If this is not achieved, the best possible symmetry with the weakest prism is sought. This means that any remaining stereo delays should be as equal as possible in both types of presentation and as low as possible.

<u>For case 2</u> (no depth perception):

Indicate that the fixation point should be looked at, that it is at a fixed distance and that the triangles could be seen in front of or behind the point.

Example wording:

"Please look at the point. Are the triangles in front of or behind it?"

If the answer is hesitant, ask further questions:

"... or are the triangles and the point the same distance away?"

If depth perception is finally achieved through specific questions, then continue as described in case 1 (check for stereo delay).

If there is no stereopsis, possible causes should be considered depending on the medical history and preliminary examinations and, if necessary, further tested using the stereo dominance test. For causes of missing stereopsis, see page 56.

<u>For case 3</u> (diplopia):

First, clarify whether diplopia (of the triangles or the dot) occurs in *both* types of presentation.

If diplopia occurs in only *one* type of presentation, proceed as for stereo delay in only one type of presentation (horizontal prism according to stereo rules, Table 1). The initial aim is to eliminate the diplopia. Subsequently, check for stereo delay.

If diplopia occurs in both types of presentation, restricted panum areas are assumed. In this case, a stereo delay test with a smaller stereo angle is used. If diplopia is also present there (which is very rare), the stereo delay test is discontinued, the stereo dominance test is skipped and the test is switched directly to the stereo acuity test.

For case 4 (incorrect assignment):

> *Example: The triangles are perceived in converse presentation behind the fixation point.*

In these very rare cases, the generated cross disparity is incorrectly evaluated by the sensory system. No prism steps can be derived from such sensory anomalies.

Therefore, the heterophoria determination for distance is interrupted at this point and, at most, the prism determined in the cross tests for distance and near vision is transferred to the correction, provided that motor relief is indicated for exertion complaints.

Notes on stereoscopic depth

Optionally, the stereo delay test can be used to determine the stereoscopic depth forward (in converse presentation). To do this, the examiner can use his hand to locate the position of the triangles in space based on the patient's instructions and estimate their distance from the test plane.

The calculated stereoscopic depth depends on various parameters (including the patient's pupillary distance).

Examples for a test distance of 6 m and a stereo parallax of 20 mm:

- Stereoscopic depth (forward) at PD 60 mm: 1.50 m
- Stereoscopic depth (forward) at PD 70 mm: 1.33 m

For geometric reasons, the stereoscopic depth for stereo objects behind the fixation object (perception in inverse presentation) is always greater than for stereo objects in front of the fixation object (perception in converse presentation). Therefore, no prism steps may be derived from this difference.

The perceived stereo depth indicates the current quality of the sensory evaluation of the cross-disparate image.

There are various possible causes for insufficient stereo depth:

1. Full correction has not yet been achieved.
   In this case, the stereo depth often improves through prism steps in further tests, especially in the stereo dominance test.

2. Despite full correction, complete sensory feedback to bicentral correspondence has not (yet) taken place.
   In this case, the stereo depth usually improves after wearing the prismatic correction for an extended period.

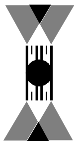
Since it is not possible to distinguish the cause at first, no prism change should be made due to insufficient stereoscopic depth in the stereo delay test.

Nevertheless, recording the perceived stereoscopic depth can be useful for monitoring progress.

12.8 Stereo dominance test

DE: Stereo-Dominanztest (vormals: Stereo-Valenztest, Valenz-test, Stereo-Sehgleichgewichtstest)

Abbreviation: SDT

	In converse presentation, the two left triangles are assigned to the right eye and the two right triangles to the left eye, while the central point with the scales is presented to both eyes. In inverse presentation, the assignment of the triangles is reversed.

Terms

- **Stereo valence**

  Relationship between the two eyes in stereoscopic directional perception.

- **Stereo dominance** (formerly: stereo prevalence, anisova-lence)

  The dominance of one eye (and thus the inequality of both eyes) in in stereoscopic directional perception .

  Note: Stereo dominance leads to the perception of lateral displacement of the triangles in this test.

- **Stereo equivalence** (formerly: isovalence)

  Equality of the two eyes in stereoscopic directional perception in either crossed or uncrossed lateral disparity.

Note: In stereo equivalence, the triangles in the stereo dominance test are perceived centrally to the scales in one presentation mode, while in the other presentation mode, lateral displacement of the triangles may still occur.

- **Stereo visual balance**

Simultaneous presence of stereo equivalence in both types of presentation.

Note: With stereo visual balance, the triangles in the stereo dominance test are perceived centrally to the scales in both types of presentation.

Misuse of the term "prevalence"

Since prevalence (more precisely: stereo prevalence) is a property of the *eye* in the context of MCH, this term should no longer be used to describe *test perception*, contrary to long-standing practice, including within the IVBS.

A change in the type of presentation does not influence stereo prevalence, i.e., the stereo dominance of the leading eye in terms of position.

Accordingly, statements such as "greater prevalence in inverse presentation" as a description of a greater displacement of the triangles in this type of presentation or "prevalence to the right" as a description of the displacement of the triangles in this direction are misleading.

To avoid such misunderstandings, the term stereo dominance was introduced.

Intended use

- Prismatic compensation of the third to sixth subtypes of disparate correspondence (FD II/3-6, fixed FD) and motorically compensated heterophoria components that had not yet relaxed.

- Clarification of whether stereo dominance exists in this test.

Forms of implementation

The stereo dominance test is available with different stereo angles.

Standard: Stereo angle 12.5' (corresponds to 20 mm stereo parallax at a test distance of 5.5 m).

If this standard version was not used, the stereo angle (or stereo parallax at the test distance) used for testing must be documented.

Function

In the converse presentation type, the triangles are presented to the right eye, pointing to the left outer scale mark and to the left eye, pointing to the right outer scale mark. Only if both eyes are equally involved in the formation of binocular spatial perception will the triangles be perceived as pointing to the centre of the scales after both individual images have been processed. (Fig. 6)

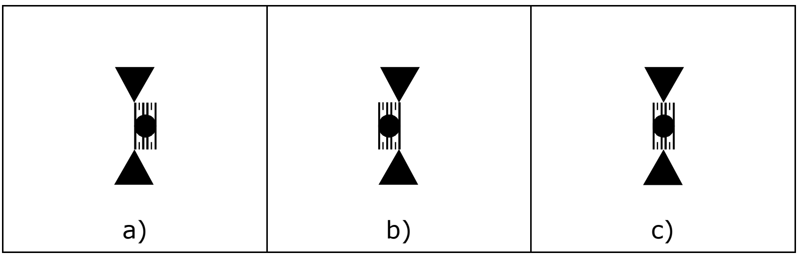


Fig. 6: Visual impressions in the stereo dominance test; a) visual impression of the right eye in converse presentation; b) visual impression of the left eye in converse presentation; c) ideal binocular visual impression

However, if one of the eyes is stereo-dominant, its monocular visual impression will prevail in binocular vision, i.e., the triangles will be perceived with a lateral displacement (to the right or left). However, such a shift can also be caused by a functional inequality between the two eyes (in terms of visual acuity, contrast sensitivity, etc.).

Despite otherwise functional equivalence, pairs of eyes with consolidated FD no longer work together equally. The stereo dominance test then shows a lateral displacement of the triangles. To derive the appropriate prism base position, the perception in *both* types of presentation must always be compared.

Reason:

- With exo-FD, there is greater lateral displacement of the triangles in converse presentation.
- With eso-FD, there is greater lateral displacement of the triangles in inverse presentation.
- With vertical FD, there is equal lateral displacement of the triangles in both types of presentation.

The extent of lateral displacement of the triangles depends on the degree of inferiority of the non-dominant eye. This is determined by the intensity of visual inhibition and the size of the FD (distance of the disparate correspondence centre from the centre of the fovea).

Test explanation and application

Firstly, it should be noted that this test is not intended to assess spatial depth, but rather the lateral displacement of the triangles in relation to the scales.

If necessary, the maximum possible lateral displacement of the triangles (to the end of the scales) can be demonstrated by covering one eye at a time.

Due to the spatial depth of the triangles, assessing their horizontal position is quite challenging. If visual acuity is insufficient (less than 0.8), the assessment can be made even more difficult because the fine scale lines cannot be sufficiently recognised. Therefore, the examiner must adapt their questioning so that the patient is not unsettled or overwhelmed.

In the further course of the examination, attention is paid to whether one of the following cases exists:

Case 1: Lateral displacement of the triangles

Case 2: Diplopia of the triangles or the dot (with scales)

<u>Case 1</u> (displacement):

At the beginning, the triangle positions are queried as accurately as possible:

- Separately in both presentation modes
- For the top and bottom, respectively

In the case of lateral displacement of the triangles, regardless of whether prisms are already in the trial frame, a first trial prism step is first carried out in accordance with the following stereo rules:

Table 2: Stereo rules for the stereo dominance test

Displacement	Trial measure
Larger with converse presentation	Check with prism base in
Larger with inverse presentation	Check with prism base out
Same size in both types of presentation	Check with prism base up or down

Special case:

Different lateral displacements of the upper and lower triangles in one type of presentation indicate a vertical error. If a vertical prism has already been determined, it is first increased on a trial basis.

The effect of each prismatic change is checked by re-querying the lateral position of the upper and lower triangles in both types of presentation.

If the lateral displacement of the triangles has been reduced but not yet eliminated, the next prism step must be determined in accordance with the stereo rules (Table 2).

> *Example: At the beginning, lateral displacement is the same in both types of presentation. After modification with a vertical prism: Lateral displacement only occurs in one type of presentation; now test with a horizontal prism on a trial basis.*

If lateral displacements cannot be eliminated or at least reduced by these stereo rules, the remaining errors are also checked with the other base positions in both types of presentation.

Note on the stereo rules

In the stereo delay test, "incorrect" fixation (looking at the triangles instead of the fixation point) can lead to an apparently contradictory stereo delay (e.g., in esophoria, delay forward instead of backwards). For this reason, the stereo delay test distinguishes between two initial situations (with/without prisms in the trial frame). Due to the rule applicable in most cases, which is first to try increasing the prisms determined in the previous tests, such misunderstandings often do not occur in the first place.

Such contradictions cannot occur in the stereo dominance test, because stereo dominance cannot switch between the two eyes when the patient looks at other parts of the test. Therefore, the stereo rules specified for this test apply in all cases (with or without prisms in the trial frame); they correspond to the stereo rules for the stereo delay test for initial situation B.

Sequence of prism steps

- Size of the first prism step: 0.25^{Δ}

Hold up the respective measuring prism and only insert it into the trial frame if there is a lasting improvement; otherwise, *remove* it and proceed in the same way with the next strongest measuring prism.

Reason: A measuring prism that does not cause a lasting improvement must be removed again; otherwise, there is a risk of overcorrection (see p. 62).

This also helps to avoid measurement errors caused by possible evasive movements of a centrally inhibited eye.

For this reason, prismatic lens bars should not be pulled through, and there should be no continuous amplification of the prismatic power (therefore, no prism compensators should be used).

If the lateral deviation is permanently eliminated with the first measurement prism held in place on a trial basis

- is permanently eliminated:
  Use 0.25^{Δ} and exit the stereo dominance test

- is permanently reduced:
  Use 0.25^{Δ} and additionally hold 0.25^{Δ} on a trial basis* (if necessary, with a different base position, see example above)

- remains unchanged or is only reduced briefly (at the first moment of presentation):
  0.25^{Δ} must be removed again and 0.5^{Δ} presented on a trial basis* (with the same base position)

**If necessary, take further prism steps in increments of 0.25^{Δ} (based on experience, up to approx. 1.0^{Δ}).*
If the release of tonus is suspected, these motor components should first be compensated for in the cross test. The measurement is then continued in the stereo dominance test.

To detect slight differences between the upper and lower triangle positions, ask whether the triangle tips are pointing exactly at each other.

To detect slight (residual) deviations from the centre of the scale, it can be helpful to quickly change the type of presentation. If the triangles jump sideways, stereo vision balance has not yet been achieved.

There are various possible causes for persistent lateral deviations of the triangles that are equally large in both types of presentation:

- Visual inhibitions that have not yet been resolved (and thus continued stereo dominance of the opposite eye)
- Vertical FD components that have not yet been corrected
- Refraction imbalance
- Functional inequality of both eyes (differences in visual acuity or contrast), caused, for example, by amblyopia, unilateral eye diseases, corneal irregularities or developmental deficits

At least during the first measurement of heterophoria with consolidated fixation disparity, even with full prismatic correction, it cannot always be expected that stereo vision balance will be achieved immediately. Reason: Persistent visual inhibitions initially prevent equal processing. The resulting persistent stereo dominance is only eliminated by wearing the prismatic full correction for a more extended period. If stereo vision balance is not achieved as a result, microstrabismus should be considered.

Test criterion

A prism held up on a trial basis is only inserted into the trial frame if this reduces the lateral displacement of the triangles. The perception of greater spatial depth is not a test criterion.

In the stereo dominance test, apparent improvements may occur at certain prism steps, but these can lead to misinterpretations. This is due to visual inhibitions associated with consolidated fixation disparity, which can be particularly pronounced in the retinal centre of the FD eye. The closer the retinal image is to this inhibited retinal area, the more unstable the perception may be at first.

If the prismatic power is tentatively weakened during fine adjustment due to persistent stereo dominance, the patient may spontaneously perceive this change as better, calmer or more pleasant because the image has been shifted to a less inhibited area of the retina. In the long term, however, visual inhibitions can only be resolved by a bicentric image position, which is often essential for a compatible prismatic correction.

In the case of established sensory adaptations, it is to be expected that the relaxed vision sought with a prismatic correction will not occur spontaneously, but only after a longer period of wear (up to six weeks, based on experience). Therefore, the patient's subjective perception during or immediately after the measurement is not a test criterion in such cases.

In principle, the following applies:

Only when the lateral deviation of the triangles has been eliminated or clearly reduced is a prismatic change incorporated into the trial frame.

Desired test perception

The triangles should be perceived in both types of presentation without lateral displacement, i.e., centred on the fixation object (point with scales).

If this is not achieved, the best possible symmetry is sought with the weakest prism. This means that any remaining lateral displacement should be as equal as possible in both types of presentation and as small as possible.

Placebo control with zero lens?

It is sometimes suggested that the reliability of patient statements should be checked with the aid of a zero lens and that a change in the prismatic power should only be made if the prism lens clearly indicates an improved test perception, but the zero lens does not.

However, this only works in cases where the lateral displacement of the triangles reappears when the test prism is removed.

In other cases, however, the improved test perception may remain briefly after the test prism has been removed. In this case, the zero-lens criterion can lead to incorrect measurement steps.

Explanation: Assuming that a specific prism causes central imaging in the FD eye and thus eliminates the visual inhibition that existed up to that point. By reactivating the foveola as the correspondence centre, the stereo dominance test is now perceived without lateral displacement of the triangles. This ideal state may persist for a short time even after the corresponding measuring prism has been removed. A comparison of a prism lens/zero lens would then show no difference and would even imply that the previously correctly determined prism is not present.

Accordingly, in theory, the zero lens would have to be held up before *each* individual test with a prism lens. However, this would significantly complicate the practical applicability of the stereo dominance test.

Case 2 (diplopia):

First, it must be clarified whether diplopia (of the triangles or the dot with scales) occurs in *both* types of presentation.

If diplopia occurs in only *one* type of presentation, the procedure is the same as for lateral displacement of the triangles in only one type of presentation (horizontal prism according to Table 2).

The initial aim is to eliminate the diplopia. Stereo dominance is then tested.

If diplopia occurs in *both* types of presentation, restricted panum areas are assumed. Therefore, a stereo dominance test with a smaller stereo angle is then used. If diplopia also occurs there, the stereo dominance test is discontinued and the stereo acuity test is used instead.

Typical errors in the stereo dominance test

<u>Error 1</u>: Prism steps are derived from only one type of presentation due to the lateral displacement of the triangles.

Example: You only offer the stereo dominance test in the converse presentation, and there is no shift of the triangles there. You mistakenly interpret this as an indication that full correction has already been achieved.

In fact, there is still an uncorrected portion of eso-FD. You would have obtained the decisive indication of this based on the lateral displacement of the triangles in the inverse presentation. So, you should have checked with the prism base out.

<u>Remedy</u>: Prism steps must always be derived by comparing the lateral displacement of the triangles in both types of presentation!

<u>Error 2</u>: The base position of the required prism is determined based on the direction of the lateral displacement of the triangles.

Example: You find a shift of the triangles to the right in the converse presentation and no shift in the inverse presentation. You incorrectly interpret the shift of the triangles to the right as an indication of a required prism with base out (analogous to the cross test).

In fact, however, there is still an uncorrected portion of exo-FD with stereo dominance of the left eye, and you should have increased the prism base in.

(Explanation: The exo-FD makes it challenging to evaluate the temporally disparate triangle images, and the stereo dominance of the left eye causes the perceived shift of the triangles to the right in converse presentation.

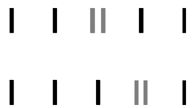
<u>Remedy</u>: The base position of the required prism must be determined by comparing the displacement *sizes* in both types of presentation (see Table 2).

12.9 Stereo acuity test

(formerly: differentiated stereo test)

DE: Stereo-Sehschärfetest (vormals: Differenzierter Stereotest)

Abbreviation: Dn (n = number of lines)

	In converse presentation, one stereo figure appears to the front in each row, with the stereo angle decreasing from row to row. In inverse presentation, the stereo figures appear in the back.

Terms

- **Stereo threshold angle**

  The smallest stereo angle at which stereopsis is present.

- **Stereo acuity**

  The threshold value of the ability to perceive slight differences in distance based solely on lateral disparate images in relative depth perception.

  The stereo angle can express the quality of stereo acuity.

Application

- If stereo visual balance has been achieved in the stereo dominance test: determine the stereo angle in both presentation modes.

- If stereo vision balance was not achieved: Fine-tuning of the prismatic correction based on the criteria of stereo threshold angle and (optionally) primary delay.

This also applies to cases in which the stereo angles in both types of presentation differ by more than one angle step despite stereo visual balance.

However, a prismatic change determined by this test must not have a negative effect on perception in the stereo dominance test.

Test variants

Stereo acuity tests are named according to the number of lines. Various variants have been developed for the MCH over the years: D5 (1970), D6 (1997), D8 (1999), D9 (1999), D10 (2014).

These abbreviations are still in use. They refer to the former designation "differentiated stereo test".

Table 3: Stereo angles in various stereo acuity tests

Line	D5	D6	D8	D9	D10
1	4'	5'	5'	5'	300" (5')
2	3'	4'	4'	4'	192" (3.2')
3	2'	3'	3'	3'	120" (2')
4	1'	2'	2'	2'	75" (1.25')
5	30"	1'	1'	1'	48" (0.8')
6		30"	30"	30"	30" (0.5')
7			20"	20"	19.2" (0.32')
8			10"	10"	12" (0.2')
9				5"	7.5" (0.125')
10					4.8" (0.08')

Since the physiological stereo angle is usually between 5 and 10" [23], tests that include a minimum stereo angle of 30" (D5 and D6) do not provide reliable results.

Requirements

Ideally, stereo acuity tests should meet the criteria listed below.

Table 4: Criteria for stereo acuity tests

Criteria	D5	D6	D8	D9	D10
Black test figures on a white background	●	●	●	●	●
No stereo figures directly below each other	●	●	●	●	●
No stereo figures in edge positions		●	●	●	●
Maximum of three lines per test field		●	●	●	●
Exclusively line-shaped test figures		●	●	●	●
Randomly generated position of stereo figures		●	●		●
Stereo angle up to approx. 5 arc seconds				●	●
Logarithmic gradation of stereo angles					●

Test explanation and application

At the beginning, the patient is asked to indicate in each line the line that he perceives with spatial depth.

[23] H. Schober: "Das Sehen", Band II, 2. Auflage, Leipzig, Fachbuchverlag (1958); S. 420

M. Millodot: "Dictionary of Optometry and Vision Science", 8. Auflage, Elsevier (2019); S. 10

In the further course of the examination, attention is paid to whether one of the following cases exists:

Case 1: Noticeably large and/or different stereo angles in both types of presentation

Case 2: Depth perception with a time delay

Case 3: No depth perception

In the case of heterophoria, prisms will already be in the trial frame at this point due to the previous heterophoria determination process, and only in this case will further prismatic test steps be carried out.

First, the existing prism is tentatively increased. If this does not result in any improvement, it is tentatively weakened.

The following rules apply uniformly to both test criteria (stereo threshold angle and primary delay) and are therefore mentioned in advance. (Table 5)

Table 5: Stereo rules for the stereo acuity test

<table>
<tr><th>Noticeable stereo angle or primary delay</th><th>Trial measure</th></tr>
<tr><td>In only one type of presentation</td><td rowspan="2">Increase horizontal prism*</td></tr>
<tr><td>In both types of presentation, but with different sizes</td></tr>
<tr><td>In both types of presentation, and with the same size</td><td>Increase vertical prism*</td></tr>
</table>

**Exceptions: See Table 1, page 60 (stereo delay test)*

Notable stereo threshold angle

At least 12" should be achieved (line 8 in D10).

Higher values are considered notable in MCH.

The stereo angle varies from person to person, and higher values may be due to factors such as age and pathological changes.[24]

Prism steps

- First prism step: hold or insert 0.25^{Δ}
- If improvement is seen: hold or insert another 0.25^{Δ}
- If there is no response: remove 0.25^{Δ}* and hold or insert 0.5^{Δ}
- Further prism steps are not recommended
- Maximum change in prismatic power in this test: 0.5^{Δ} (horizontally and vertically)

**As with the other stereopsis tests, a measuring prism that does not produce any improvement must be removed again, as otherwise there is a risk of overcorrection (see p. 62).*

For Case 1 (stereo threshold angle):

The patient should first look at the top row.

Sample question:

"There are five lines in the top row. Are they all the same distance away from you?"

The test is then carried out row by row, first in one type of presentation and then in the other.

As this test places very high demands on stereopsis, only an initial lack of depth perception does not indicate prism steps.

[24] K. Mörer, J. Vogl: "Ermittlung des Normwertes für den Stereogrenzwinkel bei Erwachsenen", Masterarbeit Beuth Hochschule Berlin (2019)

Ways to make it easier for the patient to assess

- Have the patient look at the lines of a row one at a time
- Change the presentation type
- Point out that a line can be in front of or behind
- Point out that a line is in front (in converse presentation) or that a line is behind (in inverse presentation)

If depth perception is not achieved for all rows in both presentation types, the existing prismatic correction is tentatively enhanced by holding a prism in accordance with the stereo rules in Table 5.

Subsequently, the stereo threshold angle is checked for improvement in both presentation types on the first row that was not passed.

Example wording:

"Can you now also see a line spatially in this row?"

If an increased prism power does not lead to any improvement (stereo figure correctly recognised in more rows), the remaining prism base directions in both presentation types are also checked for possible improvements.

Test criterion

A prism held up on a trial basis is only inserted into the trial frame if the position of the stereo figure is correctly recognised in at least one additional row. The perception of greater spatial depth of a line already recognised when a measuring prism is held up is not a test criterion.

In principle, the following applies:

Only if the stereo angle is clearly reduced (i.e., better stereo acuity) is a prismatic change applied to the trial frame.

To reliably determine the stereo angle, it is not sufficient to use only *one* measured value. Instead, in the threshold range – i.e., when the patient's individual performance limit is reached – the relevant stereo angle should be checked *several* times. Electronic vision testing devices enable a quick, randomly generated change of position for this purpose. Similar to the determination of visual acuity, a stereo angle is only considered to have been recognised if the position of the stereo figure has been correctly indicated four times in five consecutive presentations of the corresponding row.

Desired test perception for case 1

In both types of presentation, the stereo angle should be as equal and as small as possible.

If an identical stereo angle cannot be achieved in both types of presentation, the tolerance is that they may differ by a maximum of one angle step. This only applies to logarithmic gradation, as in D10 (constant difference by a factor of 1.5848 per angle step).

The size of the achievable stereo angle depends on individual stereo acuity.

For Case 2 (delay):

Optionally, the primary delay can then be checked by repeating the test several times. This test is performed in the line preceding the line with the current stereo angle (i.e., one line higher). In the case of different stereo angles in both types of presentation, the larger value is assumed.

Only initially delayed depth perception (during the explanation) is not considered a primary delay.

If the primary delay clearly persists even after repeated alternating tests, the existing prismatic power is tentatively increased by inserting a prism in accordance with the stereo rules in Table 5.

Subsequently, repeated alternating tests are performed to check whether the primary delay has been clearly reduced or eliminated.

If an increase of prism powert does not lead to any improvement (faster recognition of the stereo figures), the remaining prism base directions are also checked for possible improvements by means of repeated alternating tests.

Test criterion

A prism used on a trial basis may only remain in the trial frame if it has a positive effect on the primary delay. The perception of greater spatial depth is not a test criterion.

In principle, the following applies:

A prismatic change is only left in the trial frame if the primary delay has been eliminated or clearly reduced.

Desired test perception for case 2

Undelayed depth perception in both types of presentation.

If this is not achieved, the best possible symmetry is sought with the weakest prism. This means that any remaining stereo delays should be as equal as possible in both types of presentation and as small as possible.

The stereo acuity test does not check for secondary delay because the stereo depths are too small for a reliable assessment of "sliding".

<u>For Case 3</u> (no depth perception):

The patient must be given sufficient time for this test, and if necessary, an attempt should be made to make the assessment easier for them (see p. 82).

If depth perception is finally achieved through specific questions, then continue as described in case 1.

However, even the largest stereo angle available in this test may place too high demands on stereopsis. This may be due to existing visual suppressions.
In such a case, the quality of stereopsis can be checked using the stereo delay test with a smaller stereo angle (e.g., 9').

13 Control of tonus

Originally, this step was part of what was known as "reverse running". The procedure of presenting the tests in reverse order was solely due to the arrangement of the tests on a test tape.

In electronic vision testing devices, all tests can be selected directly. This enables a more efficient procedure, as it is possible to switch directly to the cross test.

The analysis of the sensory adaptation state (subtypes of FD), which was also previously performed as part of the reverse running, is described in Chapter 17, "Analysis of fixation disparity".

Purpose

To determine the cross test zero position prism after possible further muscular relaxation (release of fusional tonus) (also see p. 105).

Procedure

Following the stereopsis tests, the cross test is used to check whether fusional tonus has been released. If so, zero position perception is restored by increasing the prismatic power.

If contrast differences were still present in the cross test, care is taken to ensure that contrast equality has been established in the meantime.

The correction determination is then continued with the refraction balance test.

If overcorrection is perceived in the cross test, there may be a consolidated disparate correspondence of subtypes 4, 5 or 6. For this reason, the prismatic power should not be weakened at this point (see p. 105).

14 Binocular refractive balance for far distance

In MCH, binocular refractive balance is only performed *after* determining heterophoria for distance vision.

Reason: Without prismatic correction, exophoric patients tend to accept too much minus power due to the coupling of accommodation and vergence under binocular vision conditions (i.e., also in tests for binocular refractive adjustment). Uncorrected esophoric patients tends to assume too much plus power. In both cases, the fusion stimuli contained in the tests can trigger motor compensation, which automatically results in vergence-related accommodation.

The magnitude of the refraction error depends on the individual AC/A gradient, which averages four pdpt/D. Accordingly, even 0.25 D of accommodation would motorically compensate for 1^{Δ} of heterophoria.

In addition, sensory compensation mechanisms (fixation disparity) can complicate the test evaluation, as when looking at the test for binocular refractive balance, the best quality retinal location (fovea centre) is not used for fixation with both eyes. The presence of visual inhibitions can further complicate test perception.

For these reasons, before applying tests for binocular refractive balance, the examiner must first clarify the binocular status and, if necessary, prismatically compensate for any existing heterophoria in advance.

Purpose

The goal is to determine the final cylindrical axis and then the final spherical correction for distance vision.

Tests and their application

- <u>Cylinder axes</u>:

  The cylinder axes may differ between monocular and binocular vision.

  Possible causes:

  - Cyclo-misalignments (e.g., due to cyclophoria)
  - Prismatic corrections that contain both a horizontal and a vertical component, because the convergence position assumed with them corresponds to a tertiary position, which, according to Listing's rule, involves rotations.[25]

  Therefore, for cylinder values >1.0 D, the axis positions are rechecked using a cross cylinder under binocular vision conditions.[26] The axis positions determined in this way are to be used for the corrective glasses.

  Suitable test:

  - Separate optotypes
    (multi-line polarising comparison test)

- <u>Spherical values</u>:

  As the accommodation tone may have relaxed during the heterophoria determination, the spherical values are rechecked under binocular vision conditions.
  First, the **refractive balance** is checked. Both eyes are tested one after the other according to the rules of successive spherical fine adjustment.
  Test criterion: contrast equality.

[25] J. Laengner: "Einfluss prismatischer Brillengläser auf die Verrollung des Einzelauges", Bachelorarbeit Beuth Hochschule Berlin (2020)
[26] M. Scheiman, B. Wick: "Clinical Management of Binocular Vision", 5. Auflage, Philadelphia, Wolters Kluwer Health, Lippincott Williams & Wilkins (2020); S. 1

Suitable tests:

- MCH cross test
- Separate optotypes (multi-line polarising comparison test)
- Cowen test

The **accommodation resting position** is then checked, as the accommodation may also have relaxed to the same extent on both sides. To do this, the same spherical values are held up to both eyes simultaneously on a trial basis, first with a positive and then, if necessary, with a negative refractive power.

The test is performed with high visual acuity requirements.

Suitable test:

- Unseparated optotypes

If these two tests reveal a change in the spherical values, the prismatic values should be rechecked using the distance cross test. If this leads to further prism steps, the refractive values should also be rechecked.

Comments

Contrary to previous recommendations, the final determination of the refractive correction values (cylinder axis and sphere) is thus carried out under binocular vision conditions. This is intended to optimise the correction for binocular vision.

The MCH is not yet complete at this point because a complete heterophoria determination also requires testing with appropriate near vision tests, regardless of the patient's age.

15 Determining heterophoria for near distance

15.1 Basic principles

Heterophoria determination for near vision is used to check and, if necessary, modify the prismatic power determined in the distance tests. This means that the distance prism can possibly be optimised with the help of the near phoria tests.

In addition, a decision is made as to whether the prismatic correction for near vision should differ from that for distance vision.

Concept

An essential goal of MCH is the reactivation of bicentral correspondence. If this sensorily ideal situation has already been achieved by the prisms determined in the distance tests – recognisable by optimal perception in the stereo dominance test (stereo visual balance) – only the motor function (in the near cross test) needs to be checked.

Experience has shown that prismatic compensation for FD-related inhibitions often stabilises sensorimotor function to such an extent that satisfactory vision is achieved with the distance prism for both distance and near vision.

Explanation: The visual inhibitions of the retinal centre that often occur in heterophoria with fixation disparity not only impair distance vision, but also near vision in particular, as geometrically correct convergence would be projected into the inhibited area. As a result, convergence behaviour adapted to this disorder can become established, usually a convergence deficit, which leads to the frequently described near vision problems. These are particularly noticeable in visual tasks that place high demands on visual quality. A prismatic correction determined in distance tests, which eliminates the FD and thus the cause of the inhibitions in the centre of the retina, often allows the convergence behaviour to normalise and thus has a positive effect on near vision, even though it was determined in distance tests.

In other cases, distance and near phoria differ significantly from each other. Therefore, heterophoria determination must always be continued with MCH near vision tests. Only then can an individual decision be made as to which prismatic correction is appropriate for near vision.

Although the rules for MCH have also prescribed the use of near vision tests for decades, some critics unfortunately continue to claim that MCH often only determines binocular correction for distance and frequently neglects near vision.

The following rules demonstrate the high importance of heterophoria determination for near vision within MCH.

Procedure

A prerequisite for performing heterophoria determination for near vision is accommodation balance, even in non-presbyopes. This must be checked in advance and, if necessary, established, especially in cases of anisometropia. For this purpose, a contrast comparison can be performed using a suitable near vision test (MCH cross test, multi-line polarising comparison test, Cowen test).

In most cases, the procedure for heterophoria near vision tests does not differ from that for distance vision tests. Therefore, only the special features of the procedure for determining heterophoria in near vision tests will be discussed here.

Even in cases where the complaints only concern near vision, the heterophoria determination for distance vision must be carried out first.

Regardless of the patient's age, heterophoria must always be determined for near vision as well.

Prisms determined for distance vision remain in the trial frames. If necessary, a suitable temporary near addition should be used.

The horizontal centring of the trial frames remains unchanged (usually PCC for distance vision, see Chapter 3).

Different near vision testing devices

With current electronic near vision testing devices, the patient's individual main working distance is first entered so that the tests are displayed in the correct size. The near vision testing device is then presented at this distance.

If an older, mechanical near vision testing device is still in use, it must be presented at a test distance of 40 cm.

Required tests

A change of focus to near vision requires a change in vergence position, i.e., motor effort. The cross test for near vision is sufficient to assess this motor function.

In practice, this means that if stereo vision balance has been achieved in the stereo dominance test for distance, the heterophoria determination for near vision can be limited to the cross test.

In cases where a sensorially ideal situation could not be achieved in the distance vision tests, all other MCH heterophoria tests are also available for near vision in the same order.

The final determination of near stereo acuity, which is recommended in all cases, is used together with the determination of near visual acuity to assess the quality of near vision.

Since fusional tonus can be released simply by changing the focus from distance to near vision, the near tests should always be followed by a repeat check using the distance cross test, even if no change in the prismatic correction was made in the near vision tests.

15.2 Cross test

DE: Kreuztest

Abbreviation: C_N

The following cases may occur when performing this test:

Case 1: Zero position perception and equal contrast

Case 2: Zero position perception, but unequal contrast

Case 3: Exo-perception

Case 4: Eso-perception

Case 5: Displacement perception in the vertical

For case 1 (zero position, equal contrast):

In this ideal case, the heterophoria determination can be terminated. No additional indications of prism steps are to be expected from further near vision tests. An optimal coupling ratio between accommodation and vergence can also be assumed in this case.

For case 2 (zero position, unequal contrast):

In this case, the near test is continued with additional near vision tests, as visual inhibitions may indicate FD components that have not yet been determined.

For case 3 (exo-perception):

If there is also a displacement perception in the vertical plane, this is first compensated for prismatically.

Afterwards, an attempt is made (several times if necessary) to achieve zero position perception by increasing the test distance.

- **If this is successful** and zero position perception is maintained when slowly returning to the main working distance (or 40 cm), the heterophoria determination can be terminated, provided that stereo vision balance was maintained in the stereo dominance test for distance. Otherwise, continue testing with the pointer test for near vision.

Explanations as to why exo-perception was initially present: Exo-perception in binocular near vision tests is very common and can occur in both heterophoria and orthophoria if the test characters place only minimal demands on visual acuity. In this case, the test position can be assessed even though the eyes are not exactly focused on the test distance. Due to physiological coupling, this accommodation deficit causes the eyes to converge too little. This results in exo-perception. In addition to this non-critical cause, exo-perception can also be caused by resting position errors.

- **If it is not possible** to achieve zero position perception by increasing the test distance:

1. Try slightly increasing the distance prism

First, try to achieve zero position perception or at least a lower exo-perception by increasing the prisms determined in the distance vision tests.

Example: *Near exo-perception despite distance esophoria*
Measure: *Increase distance prism, i.e., B.a.*

Explanation of why exo-perception could not be eliminated by increasing the test distance: A central inhibition still present in the FD eye prevents the central imaging of the corresponding test portion. This results in a convergence that is too low for the test distance. This results in an exo-position regardless of the direction of heterophoria previously determined in the distance vision tests.

If such inhibitions are present, experience has shown that they can be resolved with only a slight increase (0.25 or 0.5^{Δ}) in the distance prisms.

2. Try out the other base positions

If increasing the distance prism didn't work, try out all the other base positions using the same prism steps (0.25 or 0.5^{Δ}).

Here, too, we assume that there are still FD-related visual inhibitions.

3. Larger prism steps with base in

It is possible that the change from distance to near vision testing has relaxed the fusional tonus, revealing (further) motor components of exophoria, which manifest themselves (both at a distance and near) as undercorrection perception.

Another cause of greater exo-perception at near distance: The resting position error when looking at near objects deviates from that when looking at distant exo-objects.

Examples:

- *Far distance: 2^{Δ} B.i., near distance: 5^{Δ} B.i.*
- *Far distance: 6^{Δ} B.a., near distance: 4^{Δ} B.a.*

In this case, it may be useful to determine the AC/A in order to observe the normalisation of this value during follow-up.

For possible different prismatic corrections for distance and near vision, see Chapter 15.4.

Initially, 1.0^{Δ} B.i. is given. The size of further prism steps depends on the effect of the previous step.

For case 4 (eso-perception):

- If esophoria or orthophoria was determined in the distance vision tests, fusional tonus has been released, which manifests itself (both at a distance and up close) through a perception of undercorrection.
- If esophoria and vertical deviation occur simultaneously, the larger of the two should be corrected first until both displacements are approximately equal. Then reduce the displacement in both directions alternately in small steps.
- Horizontally, 1.0^{Δ} B.a. is initially given, vertically 0.5^{Δ} B.o. or B.u. The size of further prism steps depends on the effect of the previous step.
- Other theoretically conceivable combinations include the following:
  - Eso-perception at near with distant exophoria
  - Eso-perception at near with distant vertical phoria

Both cases occur very rarely and usually have a pathological background (e.g., accommodative near esotropia with convergence excess). Since these guidelines deal exclusively with the measurement and correction of heterophoria, they are not discussed here.

For case 5 (displacement perception in the vertical):

- In this case, 0.5^{Δ} B.o. or B.u. is initially given. The size of further prism steps depends on the effect of the previous step.
- In the case of anisometropia, it must be ensured that an incorrect viewing height does not cause the displacement perception.

15.3 Additional heterophoria tests for near vision

These tests are necessary if stereo vision balance has not yet been achieved in the stereo dominance test for distance vision and there may therefore still be unresolved elements of fixation disparity.

The rules for the corresponding distance tests apply to both the classic FD tests (P_N, DP_N, R_N) and the stereopsis tests (SD_N, SDT_N, Dn_N).

Finally, the stereo acuity for near vision can be determined.

15.4 Near prism or distance prism?

At the end of the heterophoria determination for near vision, the prismatic values determined must be checked at least in the cross test and the stereo dominance test for distance vision.

If different prismatic *measurements* are determined in the distance vision tests and the near vision tests, this does not automatically lead to different *correction* values for distance and near vision.

If the prismatic power determined in the near vision tests is confirmed in the distance tests (i.e., unchanged or improved perception in the cross test and stereo dominance test), it applies to both near and distance vision.

If it is not confirmed (e.g., renewed undercorrection perception in the cross test or an increased lateral displacement of the triangles in the stereo dominance test), it must be checked whether the distance prisms are also tolerable during prolonged reading at the main working distance.

In case of intolerance (e.g., significantly strained vision or even diplopia), different prismatic corrections are required for distance and near vision.

Evaluation of perception comparison at C_N

On page 44, it was explained that the following optional comparison may be useful:

1. Perception in the near cross test before the start of heterophoria determination for distance

with

2. Perception in the near cross test at the start of heterophoria determination for near vision (with distance prisms)

If the near cross test with distance prisms is perceived *better* than at the beginning, the prismatic correction is usually well tolerated for near vision as well.

Whether a displacement perception with distance prisms in the near cross test represents an improvement can only be assessed if the near cross test was tested before the heterophoria determination at far distance.

The best possible acceptance of distant prisms at near can be expected with zero position perception in the near cross test.

If perception in the near cross test with distance prisms (compared to perception before the heterophoria determination) *has not improved* or has even *worsened*, the prismatic correction may be intolerable when viewing at near.

Below are some practical examples in which perception in the near cross test was always recorded in advance and *did not improve* with the distance prisms.

Such special cases sometimes require a modified approach compared to the rules described above.

Example 1

- Distance esophoria
- Initial status in the near cross test:

  a) Zero position perception b) Exo-perception
- Near cross test with fully corrective distance prisms:

  a) Exo-perception b) Greater exo-perception

In both cases, the base-out prisms for distance vision caused a deterioration in the near vision situation.

Procedure:

- In the near cross test, try increasing the distance prism (base out) in small steps. If this reduces the exo-perception: Check the increased prism values in the distance tests.
- If this does not reduce exo-perception: Experimentally weaken the distance prism in small steps. If this reduces exo-perception: Check the weakened prism values in the distance tests.
- The decisive factor for a change in the distance prisms is unchanged good perception in the distance tests (C and SD).
- If neither slight increasing nor weakening leads to better perception in the near cross test:

a) Prescribe distance prisms and observe during follow-up care whether this stabilises near vision. Or: Weaken the base-out prisms in the near cross test until the zero position is indicated for the first time. This is likely to result in undercorrection perception in the distance cross test. This is recommended if vision problems occur primarily during near vision or if the lowest possible prism values are indicated.

b) Convergence insufficiency may be present. If the situation in the near cross test cannot be improved at least to the extent that the exo-perceptions are the same at the beginning and with distance prisms (which is rare), the prismatic correction for near vision will probably be intolerable. Further considerations then include different prismatic correction values for distance and near vision or visual training.

Example 2

- Distance exophoria
- Initial status in the near cross test: exo-perception
- Near cross test with fully corrective distance prisms: exo-perception

Despite the base-in prisms given for distance, exo-perception continues to exist at near.

Procedure:

- In the near cross test, try increasing the distance prism (base in) in small steps. If this reduces the exo-perception: Check the increased prism values in the distance tests.
- If this does not reduce the exo-perception: Try reducing the distance prism in small steps. If this reduces exo-perception: check the reduced prism values in the distance tests.
- If neither slight increasing nor weakening leads to better perception in the near cross test:

  Increase the base-in in larger steps (2.0^{Δ}) until zero is indicated in the near cross test.

  Significantly higher base-in values at near distance may be an indication of convergence insufficiency. Initially, full prismatic correction for distance should be prescribed on a trial basis to improve near vision as well. If this is not successful, visual training can be used.

  In the case of presbyopia, the lowest possible near addition should be selected so as not to counteract accommodative convergence stimuli.

Example 3

- Distance exophoria
- Initial status in the near cross test: eso-perception
- Near cross test with fully correcting distance prisms: eso-perception

There is therefore eso-perception at near distance, both beforehand and later, with the distance prisms.

Procedure:

- In the near cross test, try increasing the distance prism (base inside) in small steps. However, this will usually worsen the near situation. Even a slight weakening of the distance prisms will hardly lead to a reduction in eso-perception.

- If both occur, this is probably a rare case of accommodation and/or convergence excess. In such cases, corresponding abnormalities have usually already been detected during the anamnesis and preliminary examinations.

- In order to achieve zero position perception in the near cross test, significantly higher base-out values are then required. However, this will lead to a strong overcorrection perception in the distance cross test.

- Try holding a near addition binocularly and check in the near cross test whether this reduces the eso-perception. If this does not result in any improvement, visual training would be a possible option.

Note: Eso-perception at near distance can also occur with distant esophoria or orthophoria. In this case, however, the release of fusional tonus is assumed first (see p. 95).

16 Refractive error determination for near distance

A near vision test is also important, especially for young people, as some problems arise particularly when there is still a high degree of accommodation.

16.1 Determination of near addition

In the case of presbyopia, the final near additions for the individual's main working distance are now determined.

Ideally, the maximum accommodation success is determined for each eye (with the refractive correction values for distance vision).

If different near point distances are measured for both eyes, the near additions must be determined monocularly.

The use of a red-green test is not recommended because it does not provide any information about the accommodative power and therefore cannot be used to assess whether it is age-appropriate, for example.

16.2 Accommodation balance

This check is necessary regardless of the patient's age.

Main causes of accommodation *im*balance:

- Anisometropia
- Unilateral accommodation disorders (usually pathological)

In the case of anisometropia, looking at close objects through fully corrective distance eyeglasses always results in accommodation *im*balance, as different accommodation results are achieved despite the same accommodation effort by both eyes. Critical cases are therefore particularly anisometropia of approx. two dioptres or more in *young* people, as they still have a high accommodation capacity.

Since these patients are not yet presbyopic, they do not need a near addition, but special near eyeglasses with appropriately modified distance values (mathematically stronger lenses changed towards plus). When centring these near eyeglasses, the corresponding main direction of gaze must be taken into account in order to avoid undesirable prismatic side effects, especially in the vertical direction.

Procedure

Contrast equality is established using a suitable binocular vision *test:*

- *MCH cross test*
- *Separate optotypes*
  (multi-line polarising comparison test)
- *Cowen test*

In the event of persistent visual inhibitions, the accommodation balance should be checked monocularly. For this purpose, small but still comfortably legible text is presented. Then, for both eyes, it is checked one after the other whether the patient sets the same distance for the vision test. If this is not the case, an attempt is made to compensate for this with monocular spherical additions (± 0.25 D).

Alternatively, accommodation balance can be assessed using dynamic retinoscopy.

16.3 Near astigmatism

If near vision is less than 80% of distance vision, near astigmatism should be checked, regardless of the patient's age.

These are the main causes of near astigmatism:

- Accommodative astigmatism (due to different accommodation successes in both principal meridians)
- Cyclovergence during near vision (due to rolling of the eyes)
- Astigmatic accommodation (due to asymmetrical sclerotisation of the eye lens)

When looking at close objects through fully corrective astigmatic distance eyeglasses, accommodative astigmatism always occurs, as different levels of accommodation are achieved in the two main sections of the eye. This results in undercorrection of astigmatism when looking at close objects. Critical cases are therefore distance cylinder values of two dioptres or more in *young* people, as they still have a high accommodative capacity. This results in an accommodative astigmatism of approximately 10% of the distance cylinder value.

With increasing presbyopia, accommodative astigmatism and astigmatic accommodation decrease because the accommodative success diminishes.

Procedure

For a quick overview, contrast equality can first be checked using a fan chart at the main working distance. This check is performed monocularly so that any visual inhibitions that may exist cannot have a distorting influence.

If there are differences in contrast, the near astigmatism is then measured on the near vision tester using the cross-cylinder method. Due to the causes of near astigmatism, both the cylinder axis and the cylinder power must be checked. Analogous to binocular refractive adjustment for distance vision, the measurement is performed under binocular vision conditions.

Suitable test:

- Separate optotypes
  (multi-line polarising comparison test)

Alternatively, the measurement can be performed using dynamic retinoscopy.

If different astigmatism measurements are obtained for distance and near vision, a decision is made as to whether different correction values are required based on near visual acuity and individual vision requirements. This is also technically feasible with special progressive lenses.

The cyclovergence component cannot be measured in the usual measurement situation for determining a correction and can therefore only be taken into account mathematically (by the manufacturer using the Listing's rule).

17 Analysis of fixation disparity

Like the control of tonus, the FD analysis was originally part of the so-called "reverse running".

Unlike the control of tonus, the FD analysis is optional. It is performed during the distance vision tests.

Since further changes in the prismatic power may occur during the heterophoria determination in the near vision tests, the sensory status is only determined afterwards.

Prerequisite

Increasing of the prismatic power in the stereo dominance test for distance vision, which has led to stereo vision balance.

This includes prismatic amplifications determined in the near vision tests, which were subsequently confirmed in the stereo dominance test for distance vision.

Purpose

Distinction between the third to sixth subtypes of disparate correspondence (consolidated FD). This can provide indications of the compatibility of the determined prismatic power.

As a reminder, the first subtype of disparate correspondence (FD II/1) is detected in the classic FD tests (pointer, double pointer, rectangle test), while the second subtype (FD II/2) is detected in the stereo delay test. The third to sixth subtypes of disparate correspondence (FD II/3-6) are revealed by the stereo dominance test and are differentiated using FD analysis.

Procedure

Once stereo vision equilibrium has been achieved, perception is tested using specific heterophoria distance vision tests (with the fully corrective prismatic power for distance, modified, when appropriate, based on the near vision tests).

If necessary, a check is also made to see whether contrast equality now exists.

The analysis of the subtype of consolidated disparate correspondence is carried out according to the following scheme:

Table 6: Subtypes of consolidated disparate correspondence

Distance test	Perception	Disparate correspondence (FD II)
Cross test	Zero position	Third subtype (FD II/3)
Cross test	Oscillation between zero position and overcorrection	Fourth subtype (FD II/4)
Cross test	Permanent overcorrection	Fifth subtype (FD II/5)
Cross test and at least one of the tests P, DP, R	Permanent overcorrection	Sixth subtype (FD II/6)

Perceptions of overcorrection after compensation of fixed FD are no cause for concern. Instead, they are to be expected.

Explanations: If overcorrection is perceived after the correct application of all heterophoria tests, then a complete return to bicentral correspondence has not yet taken place. This would only occur after prolonged wearing of the correction. Therefore, weakening the prismatic power in these cases would hinder sensory reversion. If the complaints are attributed to *sensory* problems, full prismatic correction should be carried out.

However, in cases with symptoms that primarily indicate *motor* overload, it may be advisable first to prescribe undercorrection, which only relieves motor compensation (maximum cross test zero position prism).

Evaluation

The higher the subtype of disparate correspondence, the more entrenched the sensory switches (changes in direction values) are, and the more difficulty the patient will have in getting used to the prismatic full correction eyeglasses.

Note: If the FD analysis of the cross test (due to the release of fusional tonus) reveals undercorrection perception, this will, of course, be compensated for prismatically.

18 Try out

Determining the final refractive and prismatic correction values requires a try out for different viewing distances.

In addition, a wide range of information from the course of the correction determination is taken into account, in particular:

- Results of the anamnese (e.g., age, visual complaints for different distances)
- Results of the preliminary examinations (especially in the case of presbyopia: maximum accommodative range)
- Currently determined monocular and binocular measurements
- Visual performance parameters: visual acuity, stereo acuity
- Prognosis about persistent inhibitions and tonus components
- Previous corrections and associated experiences (problems, compatibility)
- Expectations of the new eyeglasses (desired improvements)
- Intended use of the eyeglasses (e.g., work, leisure, hobbies)
- Visual habits (e.g., reading distances, use of digital media)

Based on this data and observations, correction values are determined, which are then tried out.

If both ametropia and heterophoria are present, it usually makes sense to correct both to take into account the physiological coupling of accommodation and vergence. If only one visual anomaly – e.g., ametropia – is corrected, a harmonious balance between the two components cannot be achieved.

In such cases, many specialists usually prescribe only ametropia correction at first and wait to see how this affects any asthenopic symptoms. However, this approach can lead to intolerance, for example in cases of hyperopia combined with exophoria, because the convergence associated with the accommodative compensation of hyperopia is reduced.

Procedure

Try out of the intended correction values to assess compatibility under real vision conditions (with a trial frame; e.g., looking out of the window, prolonged reading)

If necessary:

- Change correction values and repeat testing (e.g., in case of intolerance)
- Repeat the measurement at a later date (e.g., in case of uncertain results)
- Test for a few days with high-quality prism foils (see p. 111)

A decision is always made on an individual basis as to whether full prismatic correction (to maintain or reactivate bicentral correspondence) or targeted undercorrection (to relieve motor strain) is indicated for the best possible optometric care.

19 Consultation and frame fitting

19.1 Explanation of the correction values

A clear explanation of monocular and binocular vision with corresponding references to the determined correction values has proven effective in practice. The time required for this is usually less than that needed for subsequent explanations. It is important to emphasise how prismatic correction can affect existing vision problems.

In particular, in cases of greater heterophoria, attention should be drawn to any visible changes in the eye position, the appearance and weight of the eyeglasses, and possible peculiarities of perception such as distortion, micropsia, macropsia and colour stereopsis.

Sample lenses, sample eyeglasses, eye models and sketches can be helpful for illustration purposes.

Depending on the individual case and the correction determined so far, the possibility of changing measurements due to further relaxation of the eye muscles and the resulting need for new lenses should be pointed out.

It can be pointed out that some experts reject prismatic corrections, among other things, because they do not attribute the symptoms caused by heterophoria to vision (see Chapter 1.6). This can prevent uncertainty that may arise if the patient is subsequently confronted with such criticism.

The IVBS leaflets can also provide additional information for the patient.

19.2 Frame selection

When choosing an eyeglass frame, the edge thickness, weight, lens size and shape, and adaptability must be taken into account.

Particularly in the case of higher prismatic powers, an eyeglass frame with the smallest possible lens size should be selected. The base position must also be taken into account (e.g., sufficient bridge width for an inside base, unobstructed temple closure for an outside base).

19.3 Anatomical frame fitting

Before determining the centring data, the selected eyeglass frame must always be adjusted to the patient's anatomy.

Here are the goals of anatomical adjustment:

- Secure, comfortable fit of the eyeglasses
- Creation of the conditions necessary to meet the optical requirements

The optical requirements consist of compliance with the parameters specified by the lens manufacturer (e.g., forward tilt angle, frame disc angle and corneal vertex distance). If this is not possible for anatomical reasons, a different frame or customised lenses should be recommended.

In the case of higher vertical prisms, care must be taken to ensure that the lenses do not touch the forehead, cheeks or eyelashes. If necessary, a modified forward tilt angle must be included in the lens calculation.

19.4 Optical frame fitting

As a rule, the centring data is determined using optically "empty" eyeglasses, because otherwise prismatic (side) effects can influence the eye position.

Since heterophoria is largely compensated for by motor functions in natural vision, the pair of eyes is approximately in an orthostatic position during the centring data acquisition. It should be noted that the eyes will later deviate towards their resting position behind the prismatic lenses.

For this reason, the centring points must be shifted both horizontally and vertically towards the resting position (i.e., opposite to the respective base position).

The IVBS recommends that the pupil centre centration (PCC) performed during the fitting of the trial frame be kept unchanged throughout the entire correction determination.

Based on these PCC values, the position of the centring points for the corrective glasses must be determined. The programme mentioned in Chapter 3 is more accurate than the so-called "Prism Rule of Thumb" for this purpose.

It should be noted that this centring correction is already performed automatically in some video centring systems.

19.5 Lens selection

When making your selection, the weight and edge thickness of the corrective lenses in question should be calculated, compared and discussed in advance.

Lens materials with the highest possible Abbe number should be preferred, as a low Abbe number is associated with strong dispersion and thus with reduced visual acuity due to colour fringing.

When using materials with a refractive index higher than 1.6, a critical balance must be struck between aesthetics, weight and imaging errors.

Prismatic powers should never be created by decentration (neither by manufacturer-pre-decentrated lenses nor by decentration of the lenses in the optician's workshop).

If this is not observed, the lenses will be miscalculated because the manufacturer assumes a different position of the main viewing points. This results in astigmatism of oblique bundles for the wearer. There is no tolerance in this regard, especially with aspheric lenses.

Prism foils

Prism foils have significantly poorer imaging quality than prismatic lenses.

Therefore, prism foils should only be used provisionally and in exceptional cases, and only for a limited period:

- To assess a suspected connection between heterophoria and symptoms
- As an interim measure to relieve muscle tension
- As a temporary solution until corrective glasses are ready
- For simple sports glasses (e.g., swimming goggles)

The prism foils used should also be of the highest possible quality.

20 Lens order and eyeglass production

To ensure that the lenses are manufactured correctly, the following points must be taken into account when ordering them:

- Information on the trial frame setting (PCC case or formula case) and, if necessary, other parameters (arrangement of the trial frame, prism tilt, CVD) (see Chapter 3)

- Desired distribution of prisms for the right and left eye (criteria: image quality, edge thickness, weight distribution)

- For frame finishing, clarify that the specified centring data already takes into account the deviation of the eyes in the resting position (see Chapters 3 and 19.4)

Workshop equipment

Minimum technical requirements in the optician's workshop:

- Vertex refractometer with prism compensator

- Parallax-free blocking device

Frame fit

With higher prismatic values, especially with base in, the fit of the glasses may change significantly after the lenses have been ground. The position of the facet (and the adjustment of the side bridges in metal frames, or the fit determined by a full bridge) must therefore always be clarified before ordering the spectacle lenses so that the CVD, viewing heights and frame disc angles are not unintentionally changed.

Subsequent changes to the fit of the finished eyeglasses, which were not taken into account when ordering the lenses, can result in a different corrective effect than intended.

Thickness reduction prisms

Before the introduction of freeform technology for the manufacture of eyeglass lenses, multifocal lenses always contained thickness reduction prisms with base down. Since their power and that of the prescribed vertical prisms added up, an uneven vertical prismatic power could occur between the two lenses. To avoid this, the optician had to calculate the order values separately in advance, taking into account the thickness reduction prisms.

Currently, the lens manufacturer first calculates the thickness reduction prisms required for optimal edge thickness distribution and then the optimal surface design to minimise monochromatic aberrations. The optician no longer has any influence on these calculations.

Without additional information (e.g., eyeglass prescription), the prescribed vertical prismatic power of such progressive lenses cannot be determined with a vertex refractometer, because even at the prism reference point, the measured vertical prismatic power is superimposed by the thickness reduction prism.

While the thickness reduction prism used to always be 2/3 of the addition, today's opticians can no longer determine its power or base position.

If the prescribed vertical prism is to be distributed evenly between both eyes, this must be explicitly stated when ordering. The edge thickness distribution may then not be optimal. Since the superimposition with the thickness reduction prisms can cause disturbing chromatic aberrations from approx. 3.5^{Δ}, the manufacturer should recommend switching to a lens material with a higher Abbe number in these cases.

21 Eyeglass delivery

21.1 Checking the fit of the eyeglasses

When the lenses are fitted, changes may have been made to the frames that have altered the fit of the eyeglasses. In this case, the originally intended anatomical and optical fit must be restored.

21.2 Promoting compatibility

The following measures can be considered to promote spontaneous compatibility with corrective eyeglasses:

- Re-establishment of prismatic correction during heterophoria tests immediately before dispensing the corrective eyeglasses (to resolve fusional tonus, which may have solidified again in the time between measurement and manufacture of the eyeglasses)

- Switching between the two presentation types several times on the stereo delay test ("adaptation session") with the corrective eyeglasses (to reactivate bicentral correspondence, which may have been lost again in cases of particularly solidified disparate correspondence (FD II/5 and FD II/6))

21.3 Instructions for use

When delivering the eyeglasses, it is advisable to discuss the goals of the correction again, especially in the case of initial corrections.

It should be made clear that if complaints arise, it may be necessary to remeasure the correction values (e.g., due to the release of tonus) or adjust the fit of the eyeglasses.

22 Follow-up check

In certain cases, follow-up care should be firmly planned, e.g., if adaptation problems are to be expected. Concrete information is provided by the anamneses, preliminary examinations and measurement procedure (including FD analysis).

Monitoring should be carried out in the following cases in particular:

- In the event of pronounced visual strain complaints (e.g., headaches or even migraines)
- In cases of occasional diplopia
- In cases of abnormalities during preliminary examinations (e.g., jerky pursuit eye movements)
- In cases of strongly consolidated sensory conditions (FD II / 5-6)
- In cases of pronounced visual inhibitions
- In cases of absent stereopsis
- In cases of high prismatic measurements (especially for initial correction)
- In cases of a hesitant release of fusional tonus, which is why increasing measurements are to be expected
- In cases of targeted undercorrection of a larger heterophoria
- In cases of different prismatic measurements for distance and near vision (and, if applicable, AC/A outside the norm)

Careful and detailed documentation of all relevant parameters forms the basis for monitoring progress. This includes a description of the initial situation (including all results of preliminary examinations), key observations from the individual tests and all measurement results (even if these were only used for control purposes).

If necessary, fixed dates for follow-up examinations should be agreed upon. Telephone inquiries about specific problems can supplement the follow-up appointments.

Appendix

Abbreviations

Abbreviation	Meaning
MCH	Measurement and correction methods according to H.-J. Haase
IVBS	Internationale Vereinigung für Binokulares Sehen (International Association for Binocular Vision)
FD	Fixation disparity
FD I / II	Fixation disparity of the first/second type
C	Cross test
P	Pointer test
DP	Double pointer test
R	Rectangle test
SD	Stereo delay test
SDT	Stereo dominance test
Dn	Stereo acuity test
$\dots_N$	Designation for near vision tests* Example: C_N

**Abbreviations without the index N refer to distance.*

Changed terms and designations

The following linguistic changes have been made compared to the previous edition of the guidelines:

Old	New
Disparation	Disparity
Lateral disparation	Lateral disparity
Fixation disparation	Fixation disparity
Type one FD	Disparate fusion
Type two FD	Disparate correspondence
Static FD	Heterophoria-related FD
Young FD	Intermittent FD
Old FD	Consolidated FD
Binocular full correction	Prismatic full correction
Correction step	Prism step, (prismatic) measurement step
Stereo triangle test	Stereo delay test
Valence test	Stereo dominance test
Differentiated stereo test	Stereo acuity test
Stereo depth perception	Stereo acuity
Spontaneous delay	Primary delay
Post-delay	Secondary delay
Prevalence	Stereo dominance, (lateral) displacement (of triangles)
Reverse running	Part 1: Control of tonus Part 2: FD analysis
Eyeglass determination	Correction determination
Normal presentation	Converse presentation

Blackness equality	Contrast equality
Accommodation balance*	Refraction balance
Test for accommodation balance*	Binocular refractive balance at far distance

**relating to distance*

The following changes had already been made in 2012:

Old	New
Angle visual defect (In German: Winkelfehl-sichtigkeit = WF)	(Associated) heterophoria
Eso-WF, Exo-WF	Esophoria, exophoria
Horizontal WF, Vertical WF	Horizontal phoria, vertical phoria
WF determination	Heterophoria determination
WF test	Heterophoria test
WF component	Heterophoria component

Further reading

The IVBS website **www.ivbs.org** contains a detailed list of individual works and books on MCH, including the three books by H.-J. Haase (in German):

– "Binokulare Korrektion" (Binocular Correction, 1980)

– "Zur Fixationsdisparation" (On Fixation Disparity, 1995)

– "Winkelfehlsichtigkeiten mit Fixationsdisparation" (Heterophoria with fixation disparity, 1999)

Numerous scientific papers can also be found there. Including them in the guidelines would have gone beyond the scope of this practical guide.

Many of the publications listed are available for free download. The list is updated regularly.

Scientific Advisory Committee

The IVBS Scientific Advisory Committee emerged from the "IVBS Working Group of Practitioners", which developed the first edition of these guidelines.

The Scientific Advisory Committee is responsible for the ongoing development of the guidelines.

The composition of this committee can be found on the IVBS website.

The Scientific Advisory Committee welcomes suggestions and constructive criticism. Please send these in writing to the IVBS.

Contact details

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Gender note

For reasons of better readability, the generic masculine form is generally used in these guidelines for personal designations and personal nouns, automatically referring to all genders equally.

International Association for Binocular Vision