Childhood amblyopia and organic eye disease are detected too late in Germany because of inadequate screening programs (1). Eye examinations carried out by pediatricians as part of mandatory screening in childhood are likely to be limited by poor examination technique. For example, the posterior segments of the eye are not examined and determination of ametropia is impossible. Even modern techniques such as photoscreening, do not reliably detect ametropia, particularly without pupillary dilatation. In addition, delayed recognition of eye disease is often attributable to inadequate implementation of the “Guidelines for screening in childhood” (2).

The resulting delay in treatment reduces the chances of achieving normal vision. Timely treatment almost always results in the restoration of normal visual acuity. In most cases, i.e. in ametropia, a correctly fitted pair of spectacles is all that is required. Unilateral strabismus requires additional occlusion treatment, in which the better eye is covered, according to a schedule calculated by the child’s age, with the aim of preventing the good eye from compensating for the affected eye, and thereby “training” the weaker eye.

The professional bodies of both ophthalmologists and pediatricians in Germany recommend that in addition to pediatric screening examinations, every child should be seen and examined by an ophthalmologist at the age of 18 months. Children should already be seen by an ophthalmologist at six months where a parent or sibling has ametropia or strabismus. Other children at increased risk (family history of hereditary eye disease, preterm birth, multiply impaired, history of ptosis, eyelid tumors, nystagmus, strabismus, cataract or an abnormal Brückner’s transillumination test) should be referred to an ophthalmologist immediately.

These guidelines do not represent an ideal solution, but appear workable and practical under everyday clinical conditions. It is mainly in the hands of the pediatrician to recognize serious visual disturbances early. A congenital cataract can lead to irreversible amblyopia which is no longer susceptible to operative intervention with the addition of spectacles or contact lens correction, unless intervention commences in the first days or weeks of life. In bilateral cataract, the window of opportunity for intervention is equally small. Children with dense bilateral cataract will develop irreversible sensory nystagmus by about three months, which persists even after removal of the cataract, and leads to amblyopia. Severe lens
opacification should be detected by the German U2 examination, or at the very latest by the German U3 examination, in order to ensure optimal treatment. It is important to remember that neither normal findings at the German U2 or U3 stage, nor normal findings at a later date are a substitute for ongoing vigilance for possible ocular disease. Many disturbances, including opacification of the lens, develop over time, with the prospect, untreated, of worsening vision. Microstrabismus (which presents as strabismus with a minor visible squint, anomalous correspondence of both eyes and monocular amblyopia to an extent unrelated to the size of the squint) is often only detected in the routine examination of children between 43 and 48 months, the so-called German U8 examination, and sometimes not until school age.

The true extent of amblyopia only becomes apparent in visual tests in which letters or numbers are densely crowded. It would be unwise to believe that normal findings in the cover test and the transillumination test exclude microstrabismus or amblyopia because the sensitivity of both tests for these disorders is limited (while one can hardly fail to detect cataract). Early diagnosis is essential for retinoblastoma (incidence approximately 1:20,000), congenital cataracts (incidence approximately 1:3,000), and for other disorders, particularly those accompanied by ametropia and strabismus. Organic eye disease and eyelid pathology are relatively rare, however they usually cause serious amblyopia when they do occur. The prevalence of amblyopia in Germany is reported as approximately 5%. No state-administered ophthalmological care programme exists in Germany.

<table>
<thead>
<tr>
<th>TABLE</th>
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<td>Brückner’s transillumination test at short and long distances. Sensitivity for amblyopia</td>
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<thead>
<tr>
<th></th>
<th>0.2–1 metre</th>
<th>3–4 metres</th>
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<tbody>
<tr>
<td>Cataract</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Myopia</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Anisometropia</td>
<td>(+)</td>
<td>+</td>
</tr>
<tr>
<td>Hypermetropia</td>
<td>–</td>
<td>(+)</td>
</tr>
<tr>
<td>Astigmatism</td>
<td>–</td>
<td>–</td>
</tr>
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+, High; (+), Moderate; –, Poor

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<th>BOX</th>
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<td>Definition of amblyopia</td>
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Amblyopia is defined as poor/reduced vision as a consequence of a disturbed development of vision, despite normal anatomic and physiological preconditions (1). The apparent functional impairment and the cardinal symptom of amblyopia is reduced visual acuity with a degree of crowding, that only becomes apparent when visual acuity is measured with optotypes that are are placed close together. The commonest causes of amblyopia are ametropia and strabismus. Organic eye disease and eyelid pathology are relatively rare, however they usually cause serious amblyopia when they do occur. The prevalence of amblyopia in Germany is reported as approximately 5%. No state-administered ophthalmological care programme exists in Germany.
ophthalmological examination, but if it were employed, starting with the German U2, consequently followed up and any unexpected findings promptly referred for ophthalmological opinion and examination, early treatment would be achieved for most patients, in contrast to the current state of play.

If applied as part of current mandatory screening, Brückner’s transillumination test could be a useful adjunct to current examinations carried out by paediatricians and generalists. It is arguably the most important method for the pediatrician to detect organic ocular disease and amblyopia in preverbal children and is therefore well suited to interdisciplinary cooperation to achieve a reduction in the incidence of lasting visual defects. In the author’s

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**Diagram**

Direction of light in the transillumination test (diagrammatic). Depending on the patient's refractive error and on accommodation, the ophthalmoscope light falls on the fundus of the eye and is more or less defocused. When accommodation is relaxed, the reflected light of the emmetropic eye is parallel to the light from the ophthalmoscope and falls almost completely on the examiner’s eye. In myopia, the reflected light is convergent so that with increasing distance an ever smaller part of the reflected light falls on the examiner’s eye. For this reason, the pupil of a shortsighted eye looks darker with increasing distance. In hypermetropia, the reflected beam of light is divergent, but only when accommodation is relaxed. If the child focuses on the examiner, the reflected light appears to be that of an emmetropic eye, and because of this, even quite severe hypermetropia can be missed.

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**Figure 1:** Normal red reflex, equal on both sides, seen in pupils without pharmacological mydriasis but viewed in a darkened room. In front of the pupil, one can see the reflex of the light source on the cornea, which usually appears slightly nasally from the center of the pupil.
extensive experience of late detected visual defects with only limited or no susceptibility to
treatment, the transillumination test has been neglected.

Transillumination test
The principle of the transillumination test arises from the fact that one sees the illuminated
part of the intraocular system through the pupil, when one’s view is synchronized with the
direction of illumination. Looking through a direct ophthalmoscope, not as when examining
the eye from a few centimetres away, but from a distance of 0.2 to 0.5 m, and then again
from a distance of 3 to 4 m away from the child’s eyes, the fundus of the eye can be seen
shining red (the red reflex). One illuminates both pupils, causing them to shine red (figure 1).
With greater pupils, or at greater distances, the pupils may also shine red similar to the
effect from flash photography or through an otoscope, which, however, is not suited to close
examination nor for the detection of ametropia. Even in severe ametropia, a normal red
reflex can be seen with the otoscope, whereas ophthalmoscopy reveals darkening.

A direct ophthalmoscope is essential of accurate screening in childhood. An examination
lamp alone is not suited to this task (2).

The child must fixate on the light of the ophthalmoscope, which usually occurs reflexly.
If necessary, one can make interesting sounds to attract the child’s attention.

Changes in the periphery of the fundus may be seen when the child is not looking into
the light. This test has the advantage of being relatively non-intrusive, and children appreciate
the examiner’s distance. To compare the red reflex of both sides, one must look through the
ophthalmoscope and illuminate both eyes simultaneously. (If one looks over the
ophthalmoscope, both pupils will appear to be black). The examination room ceiling should
be darkened, because the red reflex is most clearly visible when there is a marked contrast
with the surroundings. If the child does not open his/her eyes, either ask the mother to hold
the child and move it up and down or lift the upper eyelid gently with your thumb, and inspect
each eye from a short distance. At the same time, examine the direct pupillary light reflex.

Close examination
The distance for the first part of the examination is 0.5 m, which allows the ophthalmoscope
light to reach both eyes. In normal cases, both pupils shine equally. The brightness of the
fundus and the distribution of brightness in the pupils is equal on both sides. Even subtle
differences ought to be interpreted as pathological. In order to detect small but optically
significant changes, an examination should be conducted at closer range. Where the
examiner suffers from presbyopia, the Rekoss disc can be used to adjust the near vision
within the instrument and deliver a sharp image of the pupil (plus lens = reverse of examination
distance in m; e.g. +5 dpt for 0.2 m).

Examination at distance
In order to detect refractive error, the transillumination test should be carried out at a
distance of 3 to 4 m. Normally, the pupils look small from that distance, but shine in the same
way as if they were being viewed close up. This normal finding does not exclude pathological
changes, for example, astigmatism. Hypermetropia can be compensated for by
accommodation. For optical reasons, the red reflex becomes weaker with increasing
distance in cases of relevant myopia or uncompensated hypermetropia (diagram). A unilateral
ametropia or anisometropia is therefore easier detectable from a distance of 4 m (table).

Findings requiring ophthalmological examination
Even those cataracts invisible to the naked eye or examination lamp can be detected by the
transillumination test, as although the affected eye shines red, clouding of the lens gives the
shine a scattered appearance. A polar cataract has the appearance of a black spot or mark in
the middle of the shining pupil. Lens opacification appears variously either as a large or complete
shadow or diffuse lens clouding, i.e. more or less homogeneous shadowing in one or both
eyes, depending on its extent (figure 2). These findings require urgent investigation. An
ophthalmologist should see and examine the child on the same or next day. While shadowing
that is due to polar cataract is more apparent on closer inspection, shadowing due to refractive
error is more apparent at a distance of 3 to 4 m. Hypermetropia can only be detected when
accommodation is relaxed, and is often only detectable for a short time or not at all. Severe
myopia can always be detected. In myopia, pupils do not only appear dark at a longer distance, but also shine less brightly than those of the child’s mother, who should keep her spectacles on for this comparison. A weak red reflex at a longer distance with a normal red reflex at a closer distance is strongly suggestive of ametropia as is an inter-ocular difference in the red reflex that is only apparent from a distance, or on walking backwards while looking through the ophthalmoscope. This examination at greater distance improves the sensitivity of the transillumination test (figure 3). In a study of people with optically induced refractive error, ophthalmologists and orthoptists in the author’s department were able to detect a unilateral myopia of just 1 dioptre in more than 95% of cases. Spherical hypermetropia with an inter-ocular difference (anisometropia) of 2 dioptres or more was detectable at 4 m in 95% of cases with a false positive rate of not more than 4% (unpublished data of the author). After a short training, medical students were able to achieve similar rates (figure 4). As recognition of inter-ocular differences of the red reflex depends on the subjectivity of the examiner, generalizations about the test sensitivity and specificity for different grades of visual defect cannot be made.
In a study in Brisbane in Queensland, one examiner, who obviously looked for very slight inter-ocular differences, sensitivity of 86% for microstrabismus and refractive error was reported, although with a specificity of 65%, which is insufficient for a screening test (8). In a study in Texas Children’s Hospital, Houston, Texas, paediatric specialist trainees achieved a sensitivity of 61% for anisometropy and microstrabismus and a specificity of just 71% (9). Apart from the degree of visual defects in cases examined, these rates are dependent on the degree of the examiner’s experience and whether the transillumination test was carried out at a sufficient distance. In both of the above studies, the examination distance was not greater than 1 m. In order to detect refractive error, it is recommended to perform the transillumination test on a person who wears glasses. Test through the glasses, then without glasses, then with glasses tilted so that they only cover one eye, in each case view the eyes through increasing distances. It goes without saying that the aim should not be to refer every other child to an ophthalmologist because of transillumination test findings (figure 5).

The value of the test is in identifying children with obvious ocular findings and refer them to an ophthalmologist before the 6th month or 30th month check-ups with the knowledge that the transillumination test does not, by any measure, identify all those at risk of ambylopia and an unremarkable test does not remove the need for a thorough ophthalmological examination at the scheduled screening times (figure 6). Neonates may have visual defects that self-correct during the first few months of life as the eye develops (1). For this reason, close examination is sufficient at U2 – U3 and examining at 3 to 4 m should take place from the third month of life, that is, at the time of the so-called German U4 examination.

**Further findings**

A pupil that shines white may be indicative of a retinoblastoma. Other possible explanations may be scars from toxoplasmosis, exudative retinitis, ablatio falciformis, granuloma, persistent hyperplastic primary vitreous which can also lead to shadowing, or medullated nerve fibres. In strabismus, the red reflex is usually brighter in the squinting eye (7) because the foveola in the middle of the fovea centralis looks slightly darker and this area is only hit by the light on the fixating eye. Therefore, microstrabismus can also be identified, although not with adequate certainty. With an esotropia of 15 to 20 degrees, the red reflex of the affected eye is noticeably brighter because the light falls onto the optic disc. All these abnormal findings require immediate clarification. It is sufficient to recognize that there are abnormal findings and to refer these patients to an ophthalmologist for further investigation.

**Conclusion**

Brückner's transillumination test is a valuable investigation, that does not offer exhaustive examination in screening appointments during childhood, but does offer an important means of detecting cataracts, central fundus changes and some visual defects, in just a few seconds.
Conflict of interest statement
The author declares that no conflict of interest exists according to the Guidelines of the International Committee of Medical Journal Editors.

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