



## A Modern School Needs Deeper Insight into Vision

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### Abstract

*Our vision is more challenged than ever, and our educational methods continually require awareness to visual stimuli and visual information. Are we sure that our students really see what we expect them to see? Eighty-six children, 5 to 12 years of age, went through a vision-screening program looking into, among others; their visual acuity, attention in the visual field and eye movements in reading.*

*The results show that a specter of vision functions is developing up in teen age. Some students have serious eye motoric disturbances, which are not identified in health screening or education. Bergen University College has started a Continuing Professional Development (CPD) where teachers specialize in vision education. This have made these teachers capable to train and helped students to develop steadier eye movements and a better visual attention with effect on reading function. In future education, vision has to be focused to ensure that more students are able to complete school.*

### Background

Being able to cope with the increasing number of visual activities, which is necessary in a modern society, requires good vision. The most demanding visual activity is reading and tiny vision disturbances may cause reading problems [1]. The number of jobs that it is possible to do without effective reading skills is decreasing. Thus reading problems may later influence work opportunities and general welfare [2].

To succeed in identifying the written words, they must appear clear and distinct. This requires a huge number of visual factors and activities, both sensory and motoric, which must be activated and synchronized. We agree with Neto, Moreira and Moreira [3] when they claim that vision is one of the most relevant factors in school learning. In our high technology, texts present a variety of visual challenges. Written information is increasingly read on various screens and less frequently on paper. This results in a growing diversity of texts with different letter sizes, fonts, letter density and contrast levels. Special visual challenges, like page designs, colours and lighting conditions, are associated with digital resources in particular.

Clear and single inputs are a crucial precondition for the phonological and semantic analyses of the text and depend on more than a normal visual acuity. This article focuses on vision and visual challenges among children between 5 and 12 years of age (N=86) and provides an overview of their vision development and their vision problems. The need of vision competence in schools is discussed.

### Vision elements

Vision is not fully developed in a new-born baby, and stimulation and activation is necessary in order to improve and develop their functional vision. There are three fundamental vision activities, which Daw [4] refers to as the visual circle: 1) detecting within the visual field, 2) moving the eyes and the gaze to the detected object and 3) the active inspection of the image within the central vision. These closely linked elements include a number of vision sensory qualities and depend upon a variety of eye movements in order to function optimally. The elements in this visual circle influence each other [5, 6].

The first vision element is the ability to discover or notice objects located somewhere in the visual field other than where the gaze is fixated [4]. The visual field provides an overview of the surroundings and helps us react to and act upon visual signals [7]. Good attention to the visual field influences our reactions, and the visual signals are triggering areas in the brain stem. In this way, the eyes are activated to turn to the new spot of interest [8].

The second element in the vision circle is including the saccades [9, 10]. Both eyes have to move together in order to reach the same focus point. Continuously new visual inputs enable the brain to establish a complex and comprehensive image of the surroundings, and the saccades contribute to the development of a complete, coherent picture of the elements in the environment. Cui and Hondzinki [11] found that the gaze had a more accurate direction when both eyes were active in detecting the point within their visual fields than when only one eye was used. In the new gaze position, the image of the focal object lands on the fovea with the largest number of neurological

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receptors [12]. Fovea is critical in forming a clear picture of the details. At this point, the third element of the circle is activated – the inspection of details.

Visual acuity, VA, is a measure of the ability to see details in the picture or symbol fixated upon and is the most commonly tested vision quality. A distance VA of 1,0 is normal, but 30 % of all adults have 1,25 or more [13]. The VA measurement ought to be similar for both eyes and therefore each eye has to be checked separately in addition to a test with both eyes together. Normally the VA is better binocularly [14].

When reading close up, the optical axes have to turn inwards, convergent, in order to fixate on the same spot and the images from each eye can “fuse” into one [15]. This requires precise, finely adjusted and coordinated muscle work in both eyes for all the eye movements necessary for reading. If the convergence is not well-directed throughout the reading session, the brain will get either a double image or an unsteady or blurred image of the symbols.

## Method

Vision qualities were studied in a group of Norwegian children (N=83) between 5 and 12 years of age. The youngest were in their last year in kindergarten and the others were attending elementary school. The participating was voluntary and the parents had to sign up for the test.

Both the distance VA and the near VA were tested with LEA®-vision charts with five symbols on each line. The distance chart is developed for 3 meters and the near test for a reading distance of 40 cm. The near VA appears to be more challenging for the children. The eye movement were recorded with an eye-tracker.

## Results

The upper line in Figure 1 shows the VA measurement at 3 m distance and indicate that this capacity has reached an adult level at between 8 and 12 years of age. The dotted line is the binocular VA for a reading distance and shows that this capacity develops slower and goes on until the age of 12 years.

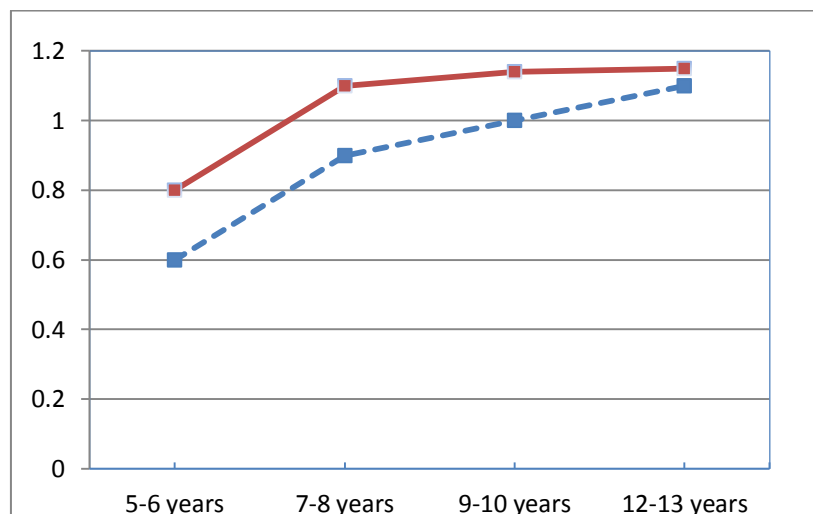


Figure 1 The upper line is the binocular VA on a 3 m distance. Dotted line is the binocular VA on 40 cm (N=80).

The differences in results for the distance VA and the near VA are due to the intensive and challenging eye motoric activities the latter requires, including convergence and accommodation. Accommodation refers to the continuous regulation of muscle adjustment of the eye lens that is required for clear vision at close quarters [16].

Eye movements by following an object sliding back and forth on the screen were mostly smooth and coordinated, but some had abnormal movements although they could have a normal VA.

## Discussion

Teachers probably assume that their pupils have a normal VA, but they seldom know if it is sufficient for seeing clearly at a distance or if it is adequate for close work. When the lens has perfect refraction for the actual distance, it will project the light onto the fovea and produce a clear image of letters and

words. In contrast, an unfocused lens with weak accommodation produces a blurry, foggy and unclear image. In order to maintain a constant VA while reading, properly functioning accommodation and binocularly convergence are required for longer periods. Sterner, Gellerstedt and Sjöström [17] confirm the finding of immature near-VA among pupils under the age of 12.

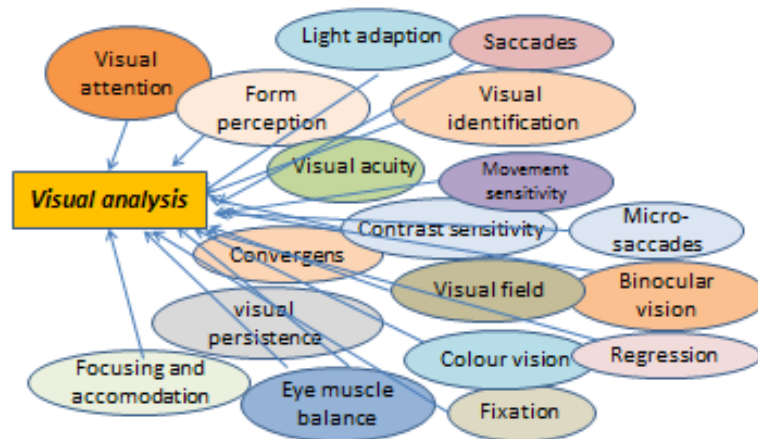


Figure 2 The essential visual analysis requires a huge number of visual components. They have to function normal and together to give clear inputs for the further process.

Incomplete near VA and immature eye motoric are reasons for the use of larger type, wider spaces and shorter texts in books for young children. Visually accessible texts provide the child with clearer input, which stimulates the visual circle. In this way, the visual features of a reading activity, including fixation, focusing, accommodation, convergence and saccades, can be stimulated and learned by the pupils in accordance with their level and stage of visual development. Figure 2 illustrate that the visual analysis requires a huge number of visual components. The youngest pupils often use their finger as eye motoric support when reading. This increases visual attention and helps the eyes to synchronize their focus on the actual spot and not shift or slip to another position. Eyes with immature eye movements may drift to different positions in the text. Tiny letters require more finely adjusted movements and a higher level of binocular cooperation.

We are reading more than ever as our communication activity increases on the various screens available. The risk of developing myopia, is higher for children who read for long periods daily [20], because the accommodation is too fixed and the lenses have problems relaxing for distance perception. Morgan, Ohno-Matsui and Saw [21] coined the term “school-myopia” for this phenomena. Myopia is most common among pupils between 11-13 years of age. A study by Rose et al. [22] revealed that 12 year olds who had spent a lot of time outdoors were less myopic than others. The solution for pupils with reading problems is often increased reading practice and, for those suffering from vision disturbances, this method will strain their vision system even more. Teachers need tools and knowledge in order to understand the vision factors involved in reading and to detect pupils facing visual challenges. Because vision is learned, it is possible to help pupils develop their vision by stimulating vision attention, eye muscles and binocular precision [18, 19, 1]. The Bergen University College has established a CPD focusing on the role of vision in children’s learning and development [23] (HiB 2014).

## Conclusion

When vision is mentioned in teaching and education, it is restricted to the special needs of children with low-vision, but teachers need a better understanding of frequent occurring vision disturbances. Vision is learned and better vision can be developed. We need to focus on all of the elements in the vision circle when preparing children for reading, and to develop a reading education program that follows the natural steps of vision development.



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