



# Viewing behavior and related clinical characteristics in a population of children with visual impairments in the Netherlands



M.J.G. Kooiker<sup>a,\*</sup>, J.J.M. Pel<sup>a</sup>, J. van der Steen<sup>a,b</sup>

<sup>a</sup> Vestibular and Ocular Motor Research Group, Department of Neuroscience, Erasmus MC, PO Box 2040, 3000 CA Rotterdam, The Netherlands

<sup>b</sup> Royal Dutch VISIO, Postbus 1180, 1270 BD Huizen, The Netherlands

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## ABSTRACT

Children with visual impairments are very heterogeneous in terms of the extent of visual and developmental etiology. The aim of the present study was to investigate a possible correlation between prevalence of clinical risk factors of visual processing impairments and characteristics of viewing behavior. We tested 149 children with visual information processing impairments (90 boys, 59 girls; mean age (SD)=7.3 (3.3)) and 127 children without visual impairments (63 boys and 64 girls, mean age (SD)=7.9 (2.8)). Visual processing impairments were classified based on the time it took to complete orienting responses to various visual stimuli (form, contrast, motion detection, motion coherence, color and a cartoon). Within the risk group, children were divided into a fast, medium or slow group based on the response times to a highly salient stimulus. The relationship between group specific response times and clinical risk factors was assessed.

The fast responding children in the risk group were significantly slower than children in the control group. Within the risk group, the prevalence of cerebral visual impairment, brain damage and intellectual disabilities was significantly higher in slow responding children compared to faster responding children. The presence of nystagmus, perceptual dysfunctions, mean visual acuity and mean age did not significantly differ between the subgroups.

Orienting responses are related to risk factors for visual processing impairments known to be prevalent in visual rehabilitation practice. The proposed method may contribute to assessing the effectiveness of visual information processing in children.

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## 1. Introduction

Over the past decades it has become evident that developmental, neurological and intellectual impairments are increasingly present in visually impaired children (Boonstra et al., 2012; Rosenberg et al., 1996). Treatable or preventable disorders have become a less common cause of low vision in children, whereas complex (genetic) and untreatable disorders

\* Corresponding author at: Department of Neuroscience, Room Ee1453, Erasmus MC, PO Box 2040, 3000 CA Rotterdam, The Netherlands. Tel.: +31 10 704 3368; fax: +31 10 704 7309.

E-mail addresses: [m.kooiker@erasmusmc.nl](mailto:m.kooiker@erasmusmc.nl) (M.J.G. Kooiker), [j.pel@erasmusmc.nl](mailto:j.pel@erasmusmc.nl) (J.J.M. Pel), [j.vandersteen@erasmusmc.nl](mailto:j.vandersteen@erasmusmc.nl) (J. van der Steen).

have taken their place. These children are characterized by a broad and heterogeneous range of medical conditions, with a variety of visual and additional impairments. An important example is cerebral visual impairment (CVI). The spectrum of CVI covers visual processing impairments as well as ophthalmologic and ocular abnormalities, such as decreased visual acuity, visual field defects and oculomotor problems (Colenbrander, 2010; Dutton, 2013; Fazzi et al., 2007; van Genderen, Dekker, Pilon, & Bals, 2012). Causes of CVI include prematurity, hypoxic–ischemic damage, metabolic disease, central nervous system infection, stroke, traumatic brain injury, structural brain anomalies, hydrocephalus, chromosomal aberrations and seizures (Soul & Matsuba, 2010). An increased risk for visual processing impairments and ophthalmologic abnormalities is also present in children with intellectual disabilities and developmental delay, due to brain damage or brain development disorders (Boot, Pel, Vermaak, van der Steen & Evenhuis, 2013; Sandfeld Nielsen, Skov, & Jensen, 2007). In general, the additional impairments or special needs prevent these children from attending regular schools. As a consequence, the prevalence of children with complex clinical pictures in special educational services for the visually impaired has increased. These schools were established to provide special and personalized care while enabling normal schooling in these children.

Currently, we are conducting a three-year longitudinal study to follow visual development in a group of 161 children with visual impairments attending special education or visual rehabilitation services in the Netherlands. In view of the fact that this population of children is very heterogeneous in terms of the nature and extent of visual and other impairments, a uniform measure of visual functioning is needed. In order to obtain meaningful longitudinal results and compare current results with follow-up assessments we aim at establishing the baseline viewing behavior in this group.

At our department, we assess visual processing in children using eye movement responses to various visual stimuli (Boot, Pel, Evenhuis, & van der Steen, 2012a; Pel, Manders & van der Steen, 2010). We apply a 4-alternative forced-choice paradigm, which does not require a verbal response or active cooperation. The principle of the task, which relates to the behavioral preferential looking task (Fantz, 1965), is that when a visual stimulus is seen and visually processed by the brain, it induces a reflexive eye movement. On the basis of the quantification of visual orienting responses in terms of reaction times one can assess the integrity of the peripheral and central visual pathways and the oculomotor system (Noton & Stark, 1971a, 1971b; Yarbus, 1967). We previously showed that impaired visual orienting responses are related to an increased risk of visual processing impairments, possibly in combination with oculomotor disorders (Pel et al., 2011). Additionally, we showed stimulus-specific delays in response times in children with visual processing impairments (Pel et al., 2013) and a relationship between the outcome measures response time and fixation quality and various clinical parameters in children with intellectual disabilities (Boot, Pel, Evenhuis, & van der Steen, 2012b).

The goals of the present study are: (1) to define baseline differences in viewing behavior between children at risk of visual processing impairments and typically developing children and (2) to develop a unified method to characterize these children at risk. To achieve this goal a large group of visually impaired children was divided into a fast, a medium and a slow responding group. Per group, we assessed the relationship between orienting responses and medical parameters such as brain damage, perceptual and ocular motor disabilities. We hypothesize that children with slow orienting responses significantly differ from children with faster orienting responses, in terms of their medical background and type and degree of visual impairments.

## 2. Method

### 2.1. Participants

Children with visual impairments (risk group) were included as part of a large longitudinal study (for a description see Appendix). Parents of children were approached through Royal Dutch Visio and Bartiméus, two institutions for blind and visually impaired people in the Netherlands. The study was executed at special schools for blind and visually impaired children and at visual advisory centers. Psychologists working at these centers selected children for inclusion based on the following criteria: (a) age between 1 and 12 years and (b) (suspected) visual information processing impairments. This involves all children that are known or suspected to have problems with the processing of visual information due to, for example, cerebral visual impairment, mild oculomotor abnormalities, albinism or other syndromes. To enable proper assessment of the test they adhered to the following exclusion criteria: (a) visual acuity  $<0.05$ , (b) severe physical disability, (c) severe epilepsy and (d) oculomotor apraxia. In total, 161 children were included in the risk group. The control group consisted of 127 typically developing children from 1 to 13 years, recruited at daycare institutions in the Alblasserwaard and Rijnmond region in the Netherlands. Exclusion criteria were (a) prematurity (born before 36 weeks of gestation) and (b) visual impairments of any kind. Written informed consent for all children was obtained via their parents. The experimental procedures were approved by the Medical Ethical Committee of the Erasmus University Medical Center, Rotterdam, the Netherlands (MEC-2012-097). The study adhered to the Declaration of Helsinki for research involving human subjects.

### 2.2. Identification of visual- and additional impairments

The risk group consisted of children attending special education for the visually impaired. Consequently, this group is characterized by broad range of visual-, cognitive- and behavioral impairments, varying in severity and degree. We thoroughly assessed the medical records of all children. First, the general diagnoses and information on etiology of the visual impairments were identified. In addition, we focused on factors that might influence orienting response times and on

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