Optotype and Grating Visual Acuity in Patients with Ocular and Cerebral Visual Impairment

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PURPOSE. To investigate the discrepancy between grating and optotype visual acuity in children with visual impairment due to brain and/or ocular abnormalities.

METHODS. Better eye acuity at 114 cm was studied in 81 patients (ages, 5–24 years) attending special schools for the visually handicapped. Fourteen patients had a brain abnormality, 48 had an ocular disorder, and 19 had both. Three acuity tasks were administered: detecting gratings in one of two positions, discriminating the orientation of single gratings, and discriminating the orientation of uncrowded Landolt-C optotypes. The three paradigms were similar in stimulus contrast, luminance, presentation mode, and psychophysical procedure.

RESULTS. Overall, grating acuity was better than optotype acuity, and the disparity increased with poorer optotype acuity. The largest discrepancies occurred in patients with brain abnormality, but disparities were also large in patients with optic nerve disorder. In patients with ocular and brain abnormality, grating acuities were only mildly better and not different from patients with only ocular abnormality. Grating orientation and grating detection tasks yielded similar thresholds, except in patients with cerebral visual impairment and with optic nerve disorder, whose grating detection acuity was better than grating orientation acuity.

CONCLUSIONS. Grating-to-optotype acuity superiority is typically large in visual disorders involving the brain. The closely matched test paradigms point to stimulus characteristics as the explanation. However, because the discrepancy decreased with grating orientation acuity instead of grating detection acuity, the complexity of the response required also plays a role. (Invest Ophthalmol Vis Sci. 2004;45:4353–4359) DOI: 10.1167/iovs.03-0822

The relationship between grating visual acuity and acuity obtained with standard recognition optotypes has been the subject of many studies. In normal eyes, there is fairly good agreement between the two measures of acuity, although recognition acuity is usually somewhat better than grating acuity from the preschool age onward.1–3 In contrast, in many patients, resolution acuity for gratings is better than recognition acuity for optotypes, particularly in those disorders that affect the macula and central vision (for review, see Ref. 1). Among these, the largest and most consistent discrepancies have been reported for amblyopia4–6 and disorders involving the optic nerve.4,7,8 In both of these conditions the origin of vision loss may not be purely ocular. Amblyopia is a cortical dysfunction, secondary to asymmetric visual input from the eyes. At least in some cases, optic nerve disease may be associated with brain disorder (e.g., in the early stage of multiple sclerosis9 or through retrograde transsynaptic degeneration after cerebral damage).10–12

Another visual disorder involving brain damage is cerebral visual impairment (CVI), and in this disorder, too, large discrepancies between grating and optotype acuity have been reported. van Hof-van Duin et al.13 found much worse optotype than grating acuity in children with hypoxic–ischemic encephalopathy and/or perinatal brain lesions, and the size of the discrepancy correlated significantly with ultrasound evidence of brain abnormality and the presence of cerebral palsy. In contrast, deviations from normal optotype to grating ratios are minimal in neonatal at-risk children in general1,14 (van Hof-van Duin J, et al. IOVS 1990;31:ARVO Abstract 915), suggesting that brain damage is the critical factor. Jacobson et al.1s compared various measures of visual acuity in a small group of children born preterm with periventricular leukomalacia and found considerably worse optotype than grating acuity, even in four children without optic nerve abnormality. In both studies, the discrepancies were evident in the binocular acuity estimates and so the results were not related to unilateral amblyopia. It seems plausible, therefore, that specific impairment in optotype compared with grating visual acuity can result from brain damage alone, and it may be a general feature of vision impairment involving brain disorder.

In the present study we wanted to substantiate this hypothesis by comparing optotype and grating visual acuity estimates from children with visual impairment due to ocular disorders, visually impaired children with ocular disorders and brain abnormalities, and children with visual impairment and brain disease but without any disabling ocular conditions. If better optotype than grating acuity is mediated by brain dysfunction, a larger discrepancy between grating and optotype acuity should be found, at least in the latter group. To learn more about the contribution of response and stimulus characteristics to the discrepancy, three different acuity paradigms were compared in which (1) the position of a grating, (2) the orientation of a grating, or (3) the orientation of a Landolt-C gap had to be indicated. All other aspects of the assessment procedures were kept constant.

METHODS

Subjects

Children were recruited from the three major schools for special education of visually handicapped persons in the Vlaams-Brabant county, Belgium, and from the multidisciplinary consultation for cerebral visual impairment, University Hospital (Leuven, Belgium). Participants in the present study were all patients who successfully completed testing with all three paradigms and who, in addition, had a reduced visual acuity of ≤ 20 cpd (i.e., below the 10th percentile of normal 5-year-old children) in the better eye on all three acuity tasks. Eighty-one patients met the criterion. Their ages ranged from 5

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to 24 years (mean, 14.4 ± 4.6), and their IQs ranged from 100 to 30 (mean, 77.1 ± 23.5). Thirty-six patients had an IQ of 85 or higher (44.4%), whereas 14 (17.5%) had a low average IQ (70–84). Fifteen patients (18.5%) were mildly retarded (IQ, 55–70) and 16 (19.8%) had moderate mental retardation (IQ < 55). The research conformed to the tenets of the Declaration of Helsinki. Informed consent was obtained from the parents or guardians of the participants.

All patients had undergone a complete ophthalmic examination, and information regarding their clinical conditions was extracted from medical records. Clinical evidence of brain abnormality was found in 33 of the 81 patients. Indications of brain involvement were abnormalities on computed tomographic (CT) scan or electroencephalogram (EEG) recordings, and neurologic signs such as cerebral palsy, motor dyspraxia, and general delay in psychomotor development. In 14 of the patients no ophthalmic abnormality was present. These will be referred to as the cerebral visual impairment (CVI) group. The other 19 patients with brain involvement had additional ophthalmic abnormalities, and will be referred to as the ocular and cerebral visual impairment (OCVI) group. The remaining 48 patients with no clinical indication of brain disease will be referred to as the ocular visual impairment (OVI) group.

Table 1 lists the primary ophthalmic diagnoses in the OVI and OCVI groups. Two children in the OVI group with Stargardt’s disease were classified in the tapetoretinal dystrophy subtype had Laurence-Moon-Biedl syndrome. The OVI and OCVI groups were further subdivided according to the ocular level of the disorder: (1) the preretinal level, comprising abnormalities in the anterior segment, (2) the retinal level, and (3) the postretinal level, consisting of optic nerve disorders. Four children had abnormalities at two levels, and they were classified according to the more posterior level of the two disorders.

Refractive errors differently affect grating and optotype acuity thresholds. Therefore, it was important that the participants wore their best optical correction during acuity testing. This was ensured by the ophthalmologists associated with the institutions where the patients were recruited. Each child underwent a complete ophthalmic examination on entering the institute and then follow-up examinations at least once a year. Each examination included objective refraction assessment with the skiascope. All patients with preretinal disorders had refractive errors. In 10 patients the better eye was hypermetropic (+4.0 to +21 D; mean, +15.7) and in 8, myopic (−1.75 to −3.25 D; mean, −2.4). In the retinal group, 12 patients were emmetropic, whereas the better eye was hypermetropic in 15 (+1.5 to +12.0 D; mean, +5.0) and myopic in 14 (−0.5 to −12.0 D; mean, −4.2). Three patients in the postretinal group were emmetropic, whereas five were hypermetropic (+0.5 to +8.0 D; mean, +3.8) and two were myopic (−3.0 and −4.0 D). Last, the better eye was emmetropic in four patients in the CVI group, whereas six CVI patients had hypermetropia (+0.25 to +7.0 D; mean, +3.1) and four had myopia (−1.5 to −11.0 D; mean, −4.4). Corrections are prescribed for hypermetropia of +2.5 D or more, myopia of more than −1.0 D, and astigmatism of 1.0 D or more.

**Stimuli**

Stimuli were administered by means of a presentation board consisting of two gray panels, 46 by 30 cm, mounted together orthogonally at their long sides. One panel contained one round aperture of 9.2-cm diameter behind which a single stimulus card could be mounted. This panel was used for presentation of the gratings in the orientation task and for the optotype stimuli. The other panel contained two similar apertures spaced apart horizontally 17 cm center to center. This allowed the administration of two stimulus cards simultaneously during the grating detection task. When one panel was used for presentation, the other served as a support on the table.

Overhead lights were turned on during testing. If there was a window, the presentation panel was oriented to catch the daylight. The luminance was measured only at the start of each session. If it was <20 cd/m², additional lighting was switched on. A preliminary study with five normal adults using the same stimulus material had shown that visual acuity remains constant at a luminance of ≥20 cd/m². The luminance at testing ranged between 46 and 141 cd/m².

The Landolt-C was chosen as the optotype stimulus instead of Snellen letters, to avoid any influence of differences in reading skills on the test results. The sizes of the C optotypes were in agreement with the A units of the traditional Keeler C chart and ranged from 30 to 0.63 cycles per centimeter in 18 steps of one-third octave, where an octave is a doubling or halving of the value. The Cs were printed in black on 9.5 × 9.5-cm white plastic cards with a 90% luminance contrast. The cards were presented with the gap of the C optotype oriented at random in one of the four orthogonal directions, and the child was
instructed to indicate the direction in which the gap was oriented (LCO task), by pointing or by verbal response.

Eighteen square-wave grating cards with similar dimensions matched the 18 Landolt-C stimulus cards in luminance contrast and spatial frequencies. In the grating orientation task (GRO) the grating cards were presented one at a time in horizontal or vertical orientation, and the child had to indicate the direction of the lines, by a gesture or by naming the direction. In the grating detection task (GRD) a grating was presented simultaneously with a luminance-matched gray field consisting of a 50% black and white subthreshold dot pattern on a similar card. The child had to indicate verbally or by pointing which of the two apertures in the gray panel contained the grating pattern. The orientation of the grating card was randomly changed between horizontal and vertical, to neutralize any orientation effects on acuity. To compensate for small luminance differences between the grating cards, three gray cards of slightly different overall luminance were used: 46.2, 50.9, and 56.3 cd/m². Under the same illumination conditions the luminance of the grating cards varied between 45.2 and 55.7 cd/m² (mean, 51.8 ± 3.4 cd/m²). The gray cards were changed for each trial, in a nonsystematic fashion, regardless of the grating presented, to ensure that no systematic relationship could arise between luminance and grating position. Under these circumstances, subjects do not respond on the basis of luminance, but attend to the spatial frequency of the gratings. This was demonstrated in a study of 205 normally developing children and 12 adults, which showed that the grating detection paradigm yields acuity thresholds consistent with previously published normative data.2

**Procedure**

Assessment was based on the forced-choice principle and proceeded in two steps. First, a quick staircase approach provided a raw localization of the threshold. Assessment started well above threshold and proceeded in blocks of two presentations per card. Spatial frequency on subsequent blocks increased by two-thirds octave (i.e., two cards) if both presentations yielded a correct response, until one error occurred. At that point the second phase started, in which cards were presented four times and subsequent cards differed by only one-third octave. Spatial frequency was increased in subsequent blocks until two (for gratings), or three (for Landolt-C), or more responses were incorrect. Then, the spatial frequency was lowered until all four responses were correct. This up-and-down sequence was continued until at least 12 responses were recorded for each of a continuous sample of cards containing one card with 100% correct responses, one card with chance level performance, and all the cards between. Testing with this up-and-down procedure could be prolonged if the examiner was uncertain about the reliability of some of the responses, up to a maximum of 18 responses per card. The threshold was defined as the finest spatial frequency that could be detected correctly in 75% of the trials for the grating stimuli and in 54% for the Landolt-C optotype. The critical percentage was different for the grating and the Landolt-C tasks, and the child had to indicate the direction of the lines, by a gesture or by naming the direction. In the grating detection task (GRD) a grating was presented simultaneously with a luminance-matched gray field consisting of a 50% black and white subthreshold dot pattern on a similar card. The child had to indicate verbally or by pointing which of the two apertures in the gray panel contained the grating pattern. The orientation of the grating card was randomly changed between horizontal and vertical, to neutralize any orientation effects on acuity. To compensate for small luminance differences between the grating cards, three gray cards of slightly different overall luminance were used: 46.2, 50.9, and 56.3 cd/m². Under the same illumination conditions the luminance of the grating cards varied between 45.2 and 55.7 cd/m² (mean, 51.8 ± 3.4 cd/m²). The gray cards were changed for each trial, in a nonsystematic fashion, regardless of the grating presented, to ensure that no systematic relationship could arise between luminance and grating position. Under these circumstances, subjects do not respond on the basis of luminance, but attend to the spatial frequency of the gratings. This was demonstrated in a study of 205 normally developing children and 12 adults, which showed that the grating detection paradigm yields acuity thresholds consistent with previously published normative data.2

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**Data Analysis**

Data from the better eye of each patient were used for quantitative analysis. Only one eye per patient was included to avoid pair-wise dependency of data points. This is particularly pertinent, because vision-impairing brain disorders—the main focus of our study—are likely to affect both eyes. The better eye was chosen to avoid confusion with amblyopia. Although amblyopia depends on cerebral mechanisms involving suppression of information from one eye, these may be different from the mechanisms occasioning visual dysfunction in CVI.

All acuity measures in cycles per degree were transformed to base 10 logarithmic values before analysis. For convenience, when discussing differences between acuity measures in the text the log10 differences are converted to octave differences (i.e., the log10 difference divided by the log10 value of 2). An octave is a doubling or halving of acuity. Appropriate parametric tests were used as specified. All statistical comparisons were evaluated at α = 0.05. Reported probabilities are two-tailed, unless otherwise specified.

**RESULTS**

The visual acuities measured with the three paradigms in patients with ocular and/or cerebral disorders are graphically compared in Figure 1. Analysis of variance revealed a signifi-
and the OCVI groups were different in their performances on contrast analyses provided no statistical evidence that the OVI acuities were also significantly different ($P < 0.001$) and a significant interaction between the paradigm used and the cause of visual impairment ($F(4,156) = 3.51, P = 0.009$).

Planned within-group comparisons, using the Bonferroni-correction for multiple comparisons, revealed as significant the interactions between GRD and LCO acuities, which showed the largest discrepancy in the CVI patients, either those with cerebral (CVI) or ocular (OVI+) visual impairment. The slopes of the two regression lines were significantly different.

The main effect of the test paradigms ($F_{(2,156)} = 36.50, P < 0.001$) and a significant interaction between the paradigm used and the cause of visual impairment ($F_{(4,156)} = 3.51, P = 0.009$). Planned within-group comparisons, using the Bonferroni-correction for multiple comparisons, revealed as significant the interactions between GRD and LCO acuities, which showed the largest discrepancy in the CVI patients, either those with cerebral (CVI) or ocular (OVI+) visual impairment. The slopes of the two regression lines were significantly different.

The relationship between grating detection (GRD) and optotype (LCO) acuity in patients with an ocular (circles) and/or cerebral (squares) origin of visual impairment. Symbols: data points of individual patients; lines: regression lines through subgroups of patients, either those with cerebral (CVI) or ocular (OVI+) visual impairment. The slopes of the two regression lines were significantly different.

The slopes of the two regression lines were significantly different ($P < 0.005$). Further contrast analyses provided no statistical evidence that the OVI and the OCVI groups were different in their performances on the different test tasks ($F_{(1,78)} = 2.54, P = 0.115$). Analysis of the contrast between these two groups and the CVI group revealed as significant the interactions between GRD and LCO ($F_{(1,78)} = 8.21, P = 0.005$) and between GRD and GRO ($F_{(1,78)} = 6.68, P = 0.012$). The interaction contrast for GRO and LCO was not significant ($F_{(1,78)} = 1.78, P = 0.186$). Because no differences were found between the OVI and OCVI groups, the data from the two groups were pooled and the combined group referred to as the OVI+ group.

Optotype acuity was generally lower than grating acuity, and the discrepancy was inversely related to the size of the visual impairment measured with optotypes, as can be seen in Figure 2. For the sake of clarity, only data are presented for the GRD and LCO tasks, which showed the largest discrepancy in the analysis of means. It is also clear from Figure 2 that the relationship between grating and optotype acuities in the CVI group was different from that in the OVI+ group. Analysis of covariance for the comparison of regression lines indicated that the slope of the regression line in the CVI group (0.365) was not different from that in the OVI+ group (0.323). In the CVI patients ($R^2 = 0.28, P = 0.019$), as were the intercepts of the two regression lines ($t_{(78)} = -2.85, P = 0.006$). The two regression lines intersected at an optotype acuity of 13.24 cyc/deg and a grating acuity of 11.82 cyc/deg.

The patients in the OVI+ group were further subdivided, depending on the type of disorder. Patients with retinal disorders comprised the largest subgroup. In Figure 3, their grating and optotype acuities are compared to those of the CVI patients. Analysis of covariance revealed that the regression line describing the relationship between GRD and LCO acuity in the patients with retinal disorders differed significantly from that describing the CVI data, both in slope ($t_{(49)} = 2.16, P = 0.036$) and in intercept ($t_{(49)} = -3.94, P < 0.001$). The intersection of the regression lines was at 12.89 cyc/deg LCO acuity and 11.72 cyc/deg GRD acuity, which is very near the intersection point for the CVI group and the entire OVI+ group.

Grating and optotype acuities of patients with preretinal ocular conditions are presented in Figure 4. The slope of the regression line in this group (0.365) was different from that in the CVI patients ($R^2 = 0.21, P = 0.853$), nor was the intercept ($t_{(28)} = -1.61, P = 0.119$). However, the regression line in the preretinal group was strongly influenced by large acuity discrepancies (≥2.0 octaves) in three patients, who may be considered outliers. Two children had a dislocation of the lens. In these children, the large discrepancy may have been of optical origin. Several studies have shown a stronger effect of optical blur on optotype than on grating visibility.3,17,18 The third child, with cataract, had additional magnetic resonance imaging (MRI) evidence of brain damage and moderate mental retardation. Because large acuity disparities were atypical of patients with cataract (see Fig. 6), the acuity results of this section of the regression lines was at 12.89 cyc/deg LCO acuity and 11.72 cyc/deg GRD acuity, which is very near the intersection point for the CVI group and the entire OVI+ group.

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Figure 2. The relationship between grating detection (GRD) and optotype (LCO) acuity in patients with an ocular (circles) and/or cerebral (squares) origin of visual impairment. Symbols: data points of individual patients; lines: regression lines through subgroups of patients, either those with cerebral (CVI) or ocular (OVI+) visual impairment. The slopes of the two regression lines were significantly different.

Figure 3. The relationship between grating detection (GRD) and optotype (LCO) acuity in patients with a retinal or cerebral origin of visual impairment. Symbols: data points of individual patients; straight lines: regression lines through subgroups of patients. The slopes of the regression lines for the patients with cerebral and retinal visual impairment were significantly different.

Figure 4. The relationship between grating detection (GRD) and optotype (LCO) acuity in patients with a preretinal or cerebral origin of visual impairment. Symbols: data points of individual patients; straight lines: regression lines through subgroups of patients. The three outliers to the preretinal group were excluded when the regression line for this group was computed. The slopes of the regression lines for the patients with cerebral and preretinal visual impairment were not significantly different.
child may reflect the cerebral disease. When the three subjects were excluded, the regression slope (0.592) became more similar to that in the patients with retinal abnormalities (i.e., 0.729) although the difference with the CVI group reached significance only for the intercepts ($t_{1,25} = 2.53, P = 0.018$) and not for the slopes.

Figure 5 depicts the relationship between grating and optotype acuity for the patients with optic nerve disease. The regression line describing this relationship did not differ significantly from the regression line in the CVI patients (slope: $t_{20} = 0.98, P < 0.340$; intercept: $t_{20} = -0.54, P < 0.589$).

The relationship of grating orientation acuity (GRO paradigm) to the other two measures of acuity (GRD and LCO paradigms) was different for different subtypes of visual impairment. Figure 6 represents average octave differences of each grating paradigm to the LCO thresholds for specific subtypes of visual disorders. On average, the 14 patients with CVI showed the largest difference between the GRO and GRD thresholds. The overestimation of optotype acuity with the GRD paradigm (mean, $-1.25 \pm 0.93$ octaves [SD]) was significantly larger in this group than with the GRO task (mean, $-0.75 \pm 0.88$ octaves; $F_{1,13} = 7.88, P = 0.015$). This suggests that the more complex orientation response required in the GRO and LCO tasks also influences the acuity result in patients with CVI.

Two other groups showed a similar relationship between GRO and GRD measures of acuity relative to LCO acuity. In the 10 patients with optic nerve disorder, the average difference between the two grating acuity tasks was comparable in size to that in the CVI group (GRD: mean, $-1.21 \pm 0.75$ octaves; GRO: mean, $-0.62 \pm 0.58$; $F_{1,9} = 7.77, P = 0.021$). In the second subgroup, comprising five children with retinitis of prematurity (ROP), the average difference between the grating paradigms was smaller, but still significant (GRD: mean, $-0.55 \pm 0.37$; GRO: mean, $-0.20 \pm 0.30$; $F_{1,4} = 10.48, P = 0.032$). There was no difference in the relative overestimation of optotype acuity by the grating paradigms for the other ocular disorder subtype. However, in the two children with displacement of the lens, the overestimation of optotype acuity by both grating paradigms was very large. It seems that in these children the large overestimation is not related to the response requirements, but to the stimulus used in the assessment of acuity. This is a further indication that the discrepancy in these two children is based on optical rather than neural mechanisms.

**DISCUSSION**

The results indicate that in many children with visual impairment, the grating acuity tasks gave different and usually better acuity estimates than did the optotype acuity task. The relationship between optotype and grating acuities depended on the size of the optotype acuity deficit. In general, the greater
the acuity deficit, the greater the disparity between a patient's grating and optotype acuities. The relationship between optotype and grating acuities also depended on the etiology of the acuity deficit. The largest discrepancies were seen in patients with visual impairment due to brain abnormality and disorder of the optic nerves. In these patients, and also in patients with ROP, the grating-orientation paradigm yielded significantly worse acuity estimates than did grating detection, albeit better than optotype acuity. In contrast, in children with disorders of the optical apparatus or the retina, the overestimation of optotype acuity by gratings was small, and grating detection and grating-orientation paradigms gave similar results.

The grating-to-optotype acuity difference found in the present study in patients with ocular disorders is in agreement with previous studies of ocular disorders other than amblyopia. In several studies, investigators have reported that the size of the discrepancy between optotype and grating acuity is inversely related to the size of the visual impairment measured with optotypes. In reviewing these studies, Dobson et al. observed that when recognition acuity was better than 20/100, the average overestimation of recognition acuity by gratings was <1 octave, whereas in eyes with recognition acuity of 20/100 or worse, overestimation by gratings was >1 octave in most studies. More recently, Arai et al. found in adult ophthalmic patients that when Snellen acuity was better than 20/60, optotype acuity tended to be superior to grating acuity derived from spatial frequency sweep visual evoked potentials. When Snellen acuity was lower than 20/60, grating acuity was superior, the discrepancy being ~1 octave for a Snellen acuity of 20/200. In our data grating detection and optotype acuities converged at ~20/75 (8 cyc/deg). At 20/200 (3 cyc/deg), grating detection acuity was, on average, 0.43 octave better than optotype acuity in the patients with retinal disease, and 0.25 octave in patients with perinatal disorders. That these values are lower than those cited earlier may be because Arai et al. included patients with optic nerve disorders. In addition, the optotype paradigms used in other studies differ from ours in many aspects that might contribute to larger discrepancies, such as use of linear optotypes, far testing, and assessment of the worse eye. These differences notwithstanding, there is now converging evidence that the overestimation with gratings is smaller in disorders not involving amblyopia or optic nerve disease, such as oculocutaneous albinism, macular disorders, generalized retinal degeneration, and cataract. Compared with patients with ocular disorders, the patients with cerebral visual impairment showed large disparity between acuities: grating detection acuity was, on average, 1.25 octaves and grating orientation 0.75 octaves better than single Landolt-C acuity. Other studies of children with brain disorders have also reported large disparities between grating and optotype acuity. In eight children with periventricular leukomalacia Jacobson et al. found an average near distance linear optotype acuity of 3.45 cyc/deg and near grating thresholds assessed with the Teller Acuity Cards were, on average, 1.25 octaves better. In 28 children with hypoxic-ischemic encephalopathy, van Hof-Van Duin et al. found an average linear Landolt-C acuity of 10.38 cyc/deg at 0.4 m. The average Teller Acuity Cards grating acuity at 0.84 m was 36.10 cyc/deg, or 1.94 octave better. In contrast to these results, several neuropsychiatric studies have reported good agreement between grating and optotype acuities in children with premature birth and low birth weight (van Hof-Van Dij, et al. IOVS 1990;39: ARVO Abstract 915), ROP, bronchopulmonary dysplasia, and cerebral palsy. The smaller difference, or sometimes even better optotype acuities, in these studies is in agreement with the better average optotype acuity of the children studied.

Within the group of patients with ocular abnormalities, those with optic nerve disorders stood out as distinct. These patients showed a large discrepancy between optotype and grating acuity. Moreover, grating acuity estimates were significantly worse when patients were asked for the orientation instead of the position of the gratings. Both features were also observed in patients with cerebral visual impairment. This raises the question of whether the optic nerve abnormalities in these patients may have been secondary to mild cerebral disease. Damage of the optic radiation or visual cortex may induce retrograde atrophy in the lateral geniculate nucleus (LGN), and even transsynaptic degeneration of retinal ganglion cells. As animal studies have shown, the susceptibility of LGN and retinal neurons is greatest early in life. Alternatively, some investigators have reported the poorest agreement between grating and optotype acuity estimates in adults who had optic nerve disease. Therefore, it may well be that, in optic nerve disorder, the discrepancy between optotype and grating acuity arises through mechanisms unrelated to those involved in cerebral visual impairment.

The mechanisms by which large discrepancies between grating and optotype acuity may arise in cerebral visual impairment are not clear. The similarity of procedures for grating and optotype tests in the present study suggests an explanation based on the nature of the stimuli. Because of their spatial extent and repetitive nature, gratings may be more efficient in driving abnormal visual channels. Optotypes, in contrast, are confined to a small area. Alternatively, most optotypes require at least some form of shape perception. Therefore, another explanation may be that damage to cortical visual areas involved in shape perception selectively interferes with the perception of optotypes. However, stimulus characteristics alone do not explain all the discrepancy observed between grating detection and Landolt-C orientation acuity. That the grating-to-optotype acuity discrepancy was significantly larger with the grating detection method than with the grating orientation task suggests that, at least in part, task-dependent factors also play a role. It has been shown that the perception of gratings can engage different cortical visual areas, depending on the task at hand. A more complicated task, such as detecting the orientation instead of the mere presence of a grating, requires different aspects of the stimulus to be processed and therefore engages different cortical circuits within the visual processing streams that can be damaged selectively.
gratings may better describe the low-level quality of the visual system. Further research is needed to investigate whether this is the case.

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