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Measuring everyday visual discrimination in visually impaired children with the Sonksen Picture Guide to visual function

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Summary

The Sonksen Picture Guide to Visual Function (SPGVF) assesses a person's ability to discriminate pictures of everyday objects. Sonksen added the SPGVF to tests of visual acuity, because real objects, miniatures, and pictures are the main learning medium for young children. In earlier studies correlations have been found between visual acuity and responses to the SPGVF. However, to date no studies have used visually impaired children. In the study reported here, the associations between performance on the SPGVF task, visual acuity and contrast sensitivity were investigated. Participants were 17 visually impaired and 29 children without disabilities, 4–6 years of age. The results showed that visual acuity was more important for picture recognition than contrast sensitivity. Contrast thresholds < 3.33% implied that not all SPGVF-pictures could be recognized. The visually impaired children in the current study showed shorter mean identification distances than the normally sighted children in the original Sonksen and Macrae study.

Keywords: visual impairment, childhood low vision, visual acuity, contrast sensitivity

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Introduction

Anyone working with young visually handicapped children will have experienced the difficulty of explaining to parents the implications of vision loss and the importance of residual vision for everyday life. Standard acuity measurement is done indoors with a minimum illumination of 500 lux for externally illuminated charts (Thompson 1993). To assess the optimal acuity level one has to use standardized acuity charts with known contrast, legibility and spacing between the optotypes. Care is also taken to reduce the number of distracting stimuli – most often by darkening the testing room – to provide optimal testing conditions. As a result, the visual acuities are only valid under these optimal visual conditions. However, the conditions under which a child faces visual tasks in everyday life are far from optimal. The contrast in visual stimuli will not always be ≥ 90%, lighting conditions may vary from darkness to bright sunlight. In addition, crowding will be present most of the time, as will be overlapping or distracting stimuli and distracting events. Therefore, a child with a certain clinically measured visual acuity may actually perform differently under normal daily living conditions than in the ophthalmologist's clinic. This is especially true for visually impaired children, because their visual functioning is more threatened by suboptimal conditions than it is for normally sighted peers. This is best shown in the atypical contrast sensitivity functions in visually impaired children (Hyvärinen & Lindstedt 1981). The generalization of results of clinical testing of visual acuity to real life is further complicated when detection or resolution tests are used instead of recognition acuity tests, as is often the case in examining young children. Recognition acuity is the ability to identify the form and shape of a target. Detection and resolution acuity represent the ability to detect whether there is an object or not and the ability to discriminate between two or more spatially separated targets (Thompson 1993). Recognition acuity is more valuable than detection and resolution acuity in relation to the demands of visual tasks in real life, in which we have to identify shapes and forms amidst distracting background information. Detection and resolution acuity are less accurate than recognition acuity methods (Dobson 1993), and resolution acuity measures tend to overestimate visual acuity compared to recognition acuity (Kushner *et al.* 1995).

Several attempts have been made to measure everyday visual discrimination and visual functioning of infants, children and adults. Some of the more well known are the Diagnostic Assessment Procedure (DAP) of the programme to develop efficiency in visual functioning of Barraga (1980) and the Look and Think checklist (Chapman *et al.* 1989; Bozic 1995). Both these instruments are part of an intervention programme to stimulate visual development in young children. Bishop (1988) promotes the use of checklists to assist observations in order to assess the visual functioning of visually impaired infants, preschool, school-aged, and children with multiple disabilities. These checklists typically

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consist of variables not covered by clinical ophthalmologic vision assessments. These variables are often of a perceptual nature, and heavily influenced by psychological and environmental factors. Sometimes these observation scales are completed by an interview with the parents. These interviews and checklists are used to assess all the visual behaviours not observable in a standard vision examination, which is mostly performed in an unfamiliar atypical environment especially for young children (e.g. Hall *et al.* 1991; Bolduc *et al.* 1993; Katsumi *et al.* 1998). A serious disadvantage of most observation scales and checklists of visual functioning is their lack of psychometric foundations. Interpretations of the results of these instruments rely heavily upon the clinical judgements of the observer. A second drawback is that most observation scales are unpublished, and, as a result of that, not available for other practitioners. The Sonksen Picture Guide to Visual Function (SPGVF) partly takes into account these two disadvantages. The instructions for the SPGVF have been published, but not the test materials, and some psychometric properties are known (see Hodes *et al.* 1994).

Initially the SPGVF was developed by Patricia Sonksen to add information about everyday visual discrimination to standardized tests that measure the minimum observable and the minimum separable (Sonksen 1983). The reasoning behind the test was that:

> At nursery age real objects, miniatures and pictures, are the learning medium of sighted children both at home and at the nursery. It is therefore logical to try to assess how well a handicapped child can see such items at different distances'. (Sonksen 1983; p. 87)

Sonksen selected pictures from the ladybird 'Baby's first Book' series that were all realistic and life size.

The test is conducted like a game of 'Grandmother's Footsteps', that is the tester starts at a distance of 3 m and steps nearer until the picture is identified. Pictures were chosen as stimuli, because they have the advantage over objects in that touch cannot be used as a clue to aid recognition. Sonksen (1983) found:

> The test (was) invaluable if done in front of the parents and teachers, who tend to overestimate children's visual ability while underestimating the way they use any previous experience of the object. (p. 88)

The clinical application of the test is that the results can be used to prescribe the type of visual material suitable for the visually impaired child.

In a second study with normally sighted children Sonksen and Macrae (1987) explored the relationship between visual acuity for single optotype

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Snellen letters and vision for realistic life-size pictures. In these children a refractive error was artificially superimposed. This study intended first of all to establish the extent to which children with different degrees of refractive error experienced difficulty with picture material; second, to select a set of pictures, out of a total of 33 pictures, which could be used as an assessment tool to help identify children needing further visual examination; third and last, to provide baseline data for a parallel study in visually disabled children. After having superimposed a refractive error, the children were allocated to either a control group or to one of five groups differing in the level of acuity. The results showed that:

1 The distance at which the pictures were recognized diminished as the degree of myopia increased.
2 The visually more simple pictures tended to be identified at greater distances than those of complex or multiple objects.
3 There was an interaction between visual acuity and the complexity of the pictures, that is, the intermediate vision groups showed steeper slopes in identifying the complex pictures compared to the simple pictures than the other groups.
4 The size of the Snellen letters seen at 3 m was much smaller than that of the component items in a picture only seen clearly at a closer distance.

Criteria were chosen to group the pictures into three grades of visual complexity. This procedure resulted in the selection of 18 pictures for the final SPGVF. For these 18 pictures the mean, mode, and range of the distances at which each picture could be successfully identified were given. Sonksen and Macrae (1987) explained the discrepancy between seeing the size of letters and the size of component items in a picture by the fact that coloured pictures are more complex than letters, because there is great variation in the spatial and spectral frequencies of the components. Furthermore, there are great differences in contrast between subject and background, in clutter and overlap of the content, and definitive value of silhouette, colour, and shape.

A study on the SPGVF with children with abnormal vision has been announced but, to our knowledge, never published. Therefore, the main goal of the current study was to study the SPGVF in a population of visually impaired children. Since the SPGFV was only studied in normally sighted children it is still unknown whether the three complexity levels for the pictures are also valid for visually impaired children. These children have different visual experiences compared to normally sighted children. Their ability to recognize pictures may therefore be different too. Given the facts that contrast sensitivity greatly affects visual discrimination (Hyvärinen & Lindstedt 1981) and contrast sensitivity is closely related to visual acuity, especially in visually impaired individuals (Thompson 1993), we decided to study the impact of contrast on performance on the SPGVF in addition to the effect of visual acuity.

The research questions were:

1 Is there an association between visual acuity and the results on the SPGVF for visually impaired children?
2 What is the impact of contrast sensitivity on the performance on the SPGVF?
3 Are there three complexity levels for the pictures for visually impaired children?

Methods

Participants

A group of 17 visually impaired children aged between 4 and 6 years participated in the study. The mean age for the visually impaired children was 5.12 (SD = 0.86). Children with colour vision deficiencies, such as achromatopsia, were not included in the study; nor were children with visual fields < 10° or coloboma or children with cortical visual impairment. The mean visual acuity of the visually impaired children was 0.45 (6/13), with a range from 0.1 (6/60) to 0.63 (6/9). Four visually impaired children had serious hearing problems, and visited a school for the deaf. The control group consisted of 29 hearing children without visual impairments, with visual acuity being 6/6. Their mean age was 5.03 (SD = 0.78). All subjects passed the vocabulary section of the MacCarthy Developmental Test before the actual experimental testing took place. This was done to ensure that the children possessed the language skills (i.e. naming of pictures and pointing to pictures) necessary to complete the tests.

Setting and materials

The children were studied in the most convenient setting. This could be at school or one of the regional early intervention centres for visually impaired children. All children were tested separately. The visual test charts were externally illuminated, with illuminance levels ranging between 650 and 800 lux.

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Whenever natural illuminance levels were below 650 lux, artificial lighting was used to achieve the minimum illuminance of 650 lux. The following tests were used:

- Everyday discrimination: SPGVF (Sonksen & Macrae 1987).
- Visual acuity: Lea Screener linear acuity test (Hyvärinen 1997).
- Contrast sensitivity: Lea symbols linear contrast test (Hyvärinen 1998).

The Lea Hyvärinen (LH) tests were chosen because they are quick and easy to use with young children. Moreover, in these tests the optotypes are presented at a distance of 3 m from the child. This distance corresponds with the starting distance in the SPGVF.

Procedure

After the illumination was measured and, if necessary, intensified to a minimum of 650 lux, the three vision tests were carried out in a fixed order. The second and third authors carried out the tests together. To ensure the procedural reliability, consensus on the child's responses was necessary. The examination started with the SPGVF. The discrete pictures were shown in a set order to the child at a distance of 3 m. After an incorrect response the viewing distance was diminished to 2, 1, 0.5 and < 0.5 m, until the child correctly identified the picture (see also Sonksen & Macrae 1987). Next, the LH acuity test was performed. The child was asked to name the four LH-optotypes (circle, square, house, and apple) at a distance of 3 m. The deaf children could point to one of four identical copies of the LH-optotypes in front of them. The LH contrast test was performed last. The maximum number of optotypes seen at 3, 2, 1, 0.5 and < 0.5 meters was noted. All the tests were performed binocular.

Results

The product moment correlations between the 18 SPGVF items and LH visual acuity are shown in Table 1. All children saw picture three, a spoon, at 3 m. As a result of this lack of variation no correlation could be calculated for this item. All other correlations were highly significant.

Contrast sensitivity is normally depicted as a contrast sensitivity function (CSF). As a result contrast sensitivity cannot easily be correlated with the SPGVF results. Peak levels or compounded values are useless because they

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Table 1 Linear correlations and partial correlations between SPGVF-items and LH visual acuity for visually impaired children ($n = 17$)

Item	Visual acuity (r*)
1. Shoe	0.59
2. Cup	0.44
3. Spoon	–
4. Ice lolly	0.54
5. Banana	0.68
6. Watch	0.83
7. Telephone	0.82
8. Pencils	0.82
9. Milk	0.75
10. Apple	0.64
11. Car	0.53
12. Socks	0.78
13. Sweets	0.85
14. Comb/brush	0.89
15. Chocolate	0.77
16. Bicycle	0.75
17. Orange	0.93
18. Buttons	0.80

*$P < 0.05$

have no clinical and practical relevance. To study the association between contrast sensitivity and performance on the SPGVF we looked for critical values of contrast sensitivity, which could affect performance on the SPGVF. In order to do so, the LH-contrast test results were plotted against the SPGVF results for each testing distance and for each child separately (for an example, see Fig. 1). The plots showed, with one exception, that whenever a child had a contrast threshold of 3.33% at a distance of 0.5, 1, 2 or 3 m he did not recognize all the SPGVF items at the same distance. A contrast threshold of 3.33% corresponds with 18 optotypes of the LH-contrast test, which in turn corresponds with a contrast sensitivity value of 30 (= 100/3.33). However, a contrast threshold > 3.33% does not guarantee that the child sees all the SPGVF pictures, as can be seen in Fig. 1.

Table 2 shows the mean and SDs for the identification distances for the three grades of visual complexity of pictures of the SPGVF for the visually impaired children. Grading procedure and final composition of the three sets are described in Sonksen and Macrae (1987). Three separate *t*-tests with Bonferroni *post hoc* multiple comparison correction showed that set 1, 2 and 3 differed significantly from each other (each $P < 0.0167$). The 29 children without

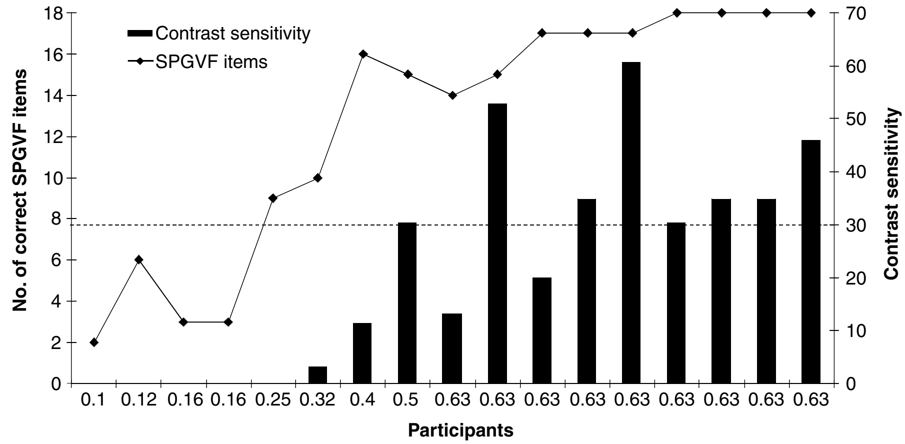

Figure 1 Number of SPGVF items correct (left y-axis) and contrast sensitivity values (right y-axis) for each visually impaired child. The children are depicted by the level of their visual acuity.

Table 2 Mean Identification Distances (MID) for SPGVF picture sets for visually impaired children

	Mean	SD	
Set 1	2.71	0.50	set 1–2, t(d.f. = 16) = 3.21, P = 0.005
Set 2	2.36	0.82	set 1–3, t(d.f. = 16) = 3.70, P = 0.002
Set 3	2.12	0.99	set 2–3, t(d.f. = 16) = 2.85, P = 0.011

visual impairments saw all the pictures at 3 m, except item 11 (apple), which was seen at 2.97 m.

The mean identification distance (MID) of the 18 pictures in the present study were compared to the MID found by Sonksen and Macrae (1987) for 6–10-year-old children with induced errors of refraction. Only the results of children with matching visual acuity were compared. These children's visual acuity was between 0.167 and 0.125. Table 3 shows the MID for the 18 pictures of both groups. The four children in the present study saw 15 of the 18 pictures at shorter distances than the 12 children in the Sonksen and Macrae (1987) study. For six pictures the MID for the visually impaired children was less than half the MID of the artificially visually impaired children. These were pictures of a banana, telephone, watch, orange, brush/comb, and socks. The differences in the MIDs could not be calculated statistically, because the

Table 3 Mean Identification Distances (MID) for visually impaired children and children with induced errors of refraction from Sonksen and Macrae (1987)

Picture	MID (m) Sonksen and Macrae ($n = 12$)	Visually impaired ($n = 4$)
Banana	2.6	1.30
Shoe	2.5	1.68
Ice-lolly	2.2	2.25
Spoon	2.2	3.00
Telephone	2.2	0.50
Car	2.1	1.55
Cup	2.0	2.25
Pencils	2.0	1.25
Watch	1.9	0.88
Milk	1.7	1.25
Socks	1.7	0.48
Apple	1.7	1.63
Chocolate	1.5	1.13
Brush/comb	1.4	0.55
Orange	1.4	0.30
Sweets	1.3	1.00
Bicycle	1.3	1.25
Buttons	0.8	0.30

standard deviations are unknown for the MIDs in the Sonksen and Macrae study.

Discussion

The results showed that performance on the Sonksen Picture Guide to Visual Function is highly correlated with visual acuity. Contrast sensitivity does not seem to be very important for recognizing the pictures, although it may be helpful. However, when the contrast sensitivity level was < 30, which means a required contrast threshold of 3.33%, not all the Sonksen pictures were seen. This suggests a threshold effect, that is there seems to be a critical value for contrast sensitivity to be able to recognize the SPGVF pictures.

The ease of recognizing pictures may greatly enhance learning from visual material, because less effort goes into the visual detection and recognition process. One could study this by looking at reaction times, which is not typically done in vision tests. In this study reaction times were not measured either.

It would be interesting to see whether children with different contrast sensitivity levels also differ in the time needed to recognize a picture. Note also, however, that recognizing a picture does not mean that the visual information in the picture is seen to the fullest extent.

In the group of visually impaired children the three sets of pictures of the SPGVF could be clearly identified. The children in the control group saw almost all the pictures at a distance of 3 m. The visually impaired children had to see the pictures, especially those from set 1 and 3, at closer distances than the control children.

The mean identification distances were generally shorter for the visually impaired children in the current study than for the children with induced errors of refraction. Six pictures were even seen at less than half the distance from the Sonksen and Macrae (1987) study. As a result, the order of pictures, arranged from large to small identification distances, differed for both groups. The picture of the telephone looks outdated, which might explain why the children in the current study needed shorter identification distances. Some caution must be taken into account when interpreting these results. Only four children in the present study matched the children in the Sonksen and Macrae study for degree of visual impairment. The latter children were also older than the visually impaired children in the present study. The differences can also be caused by differences in the use of Snellen optotypes in the Sonksen and Macrae study and LH optotypes in the current study. Visual acuity based on Snellen optotypes generally results in lower visual acuity than visual acuity based on LH symbols. This may have caused some differences in the means. Given the fact that in the end every child could name each picture, age may not explain the result that there seems to be a trend for the visually impaired children to identify the pictures at shorter distances than the children with induced errors of refraction. Two likely explanations can be given. First, the visually impaired children may have less visual experience than normally sighted children. As a result, they have more difficulty recognizing pictures than normally sighted children. Second, induced errors of refraction cause the retinal image to be blurred, whereas the visually impaired children's visual impression of the picture may easily be degraded in other ways too. Form, contrast, and hue may be affected by the visual impairment, and visual field deficits may further degrade the picture.

The present study does not specify what it is that makes the three sets of pictures differ in the distance of recognition. It could be the complexity level of the pictures, which increases from set one to three. However, also differences in contour, hue and saturation of the pictures could explain the difference in recognition distances. In contrast with letter charts the SPGVF-pictures may differ in reflection level and, as a result, luminance levels could differ per picture. This large number of confounding variables causes the practitioner using the SPGVF to be cautious in extrapolating the results from the SPGVF to everyday discrimination tasks. It is also worth noting that young children often look at books, pictures and drawings from close-up. At these distances most visually impaired children could detect the content of the SPGVF items. Further, we suggest supplementing the SPGVF with items consisting of line drawings, colour photos, and miniature sized pictures. These kind of pictures are also used in books and learning material for young children and should also be implemented in everyday discrimination tasks for young visually impaired children.

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