

# **INTERGROWTH-21<sup>st</sup>**

## **International Fetal and Newborn Growth Standards for the 21<sup>st</sup> Century**

**The International Fetal and Newborn Growth Consortium**



## **VISION ASSESSMENT MANUAL**

December 2013



**Please read this manual carefully and refer to it throughout the study  
if any clarification is needed**

This Operations Manual was produced by the INTERGROWTH-21<sup>st</sup> Infant Development Group, based on the 1<sup>st</sup> Meeting of the Group, Oxford, March 2012. This document reflects the consensus reached by members of the group regarding the selection of tests to be included in the INTERGROWTH-21<sup>st</sup> Neurodevelopment Package to be implemented by all centers taking part in the INTERGROWTH-21<sup>st</sup> follow-up study.

INTERGROWTH-21<sup>st</sup> is a large project involving health institutions from eight geographically diverse countries. It is therefore essential that all participating institutions follow a standardized neurodevelopment protocol.

# Table of Contents

Credits .....	4
Source .....	5
Introduction .....	6
Testing procedure .....	7
Principle .....	7
Apparatus.....	8
Assessment Kit .....	8
Method of Assessment .....	9
References: .....	13

# Credits

This manual was prepared by members of the INTERGROWTH-21st Infant Development Group and reflects the general consensus reached during the Infant Development Group Meeting, Oxford, 23 March 2012 regarding the selection of tests to be included in the INTERGROWTH-21<sup>st</sup> Neurodevelopment Package.

The following people made important contributions to this final version, for which we thank them:

**Michelle Fernandes** – Group Coordinator (Nuffield Department of Obstetrics and Gynaecology, the John Radcliffe Hospital, University of Oxford, Oxford, UK)

**Alan Stein** – Senior Advisor (Section of Child and Adolescent Psychiatry, Department of Psychiatry, Warneford Hospital, University of Oxford, Oxford, UK)

**Charles Newton** – Senior Advisor (Department of Psychiatry, Warneford Hospital, University of Oxford, Oxford, UK and Senior Clinical Research Fellow, KEMRI-Wellcome Trust Research Programme, Kilifi, Kenya)

**Katharina Wulff** – Expert Advisor (Associate Professor, Nuffield Department of Clinical Neurosciences, the John Radcliffe Hospital, University of Oxford, Oxford, UK)

# Source

Adoh, T. O. and Woodhouse J. M. (1994). "The Cardiff Acuity Test used for measuring visual acuity development in toddlers," *Vision Research* 34(4): 555-560

**Further information:** Dr. Michelle Fernandes, E:michelle.fernandes@obs-gyn.ox.ac.uk, T:  
+44(0)1865222936

© 2012 INTERGROWTH-21<sup>st</sup> Project

The Nuffield Department of Obstetrics & 5Gynaecology

The John Radcliffe Hospital, Oxford OX3 9DU, United Kingdom

[www.intergrowth-21st.org.uk](http://www.intergrowth-21st.org.uk)

# Introduction

The prevalence of visual impairments in children has been reported to range from 0.1/1000 children in high income countries to 1.1/1000 children in low income countries<sup>1</sup>. The major causes vary widely from region to region, and are largely determined by socioeconomic development, and the availability of health care and eye care services<sup>2</sup>. The main causes of visual impairment in children include infections, nutritional deficiencies, amblyopia, cataracts and hereditary causes<sup>1</sup>. It is estimated that, in almost half of the children who are blind today, the underlying cause could have been prevented, or the eye condition treated to preserve vision or restore sight<sup>2</sup>. Furthermore, preterm birth and low birth weight have been found to be risk factors for an increased risk of visual impairment in children<sup>3,4</sup>.

A major factor limiting the early detection of visual impairment in children relates to difficulties in measuring the visual acuity of children under the age of 4-5 years. Consequently, prevalence estimates of visual impairment in this age group are limited.

There are two key characteristics of vision that are important to assess in children. The first is a measurement of visual acuity, i.e. the ability to discern objects at a given distance according to a fixed standard. The second is a measure of contrast sensitivity, i.e. the minimum contrast necessary for a subject to detect sine wave gratings of different spatial frequencies<sup>5</sup>. Recent research has suggested that the latter may be the “single most complete measure of human spatial vision”<sup>6</sup>.

Visual acuity measurement using the standard techniques such as the Snellen chart requires levels of comprehension, concentration, and verbal skills which a young child may not possess. Techniques based on the forced choice preferential looking (FPL) method, conceived by David Teller<sup>7</sup>, are more suitable for use in young children and for use in culturally diverse settings. In the FPL, the observer presents the child with a display, half of which is plain and the other half contains a pattern. The child tends to look at the pattern if he/she can resolve it. This technique becomes a “forced choice” when the observer has to decide, based on their location of the child’s head and eye movements, where the stimulus is located. The threshold is defined as when the child makes a “clear” look<sup>8</sup>. Measurement of contrast sensitivity takes place in much the same way in children using the FPL method.

A review of measures to assess visual acuity and contrast sensitivity in children at 24 months was conducted. It was decided that for use in the follow up study of the INTERGROWTH-21<sup>st</sup> Project, the test of visual assessment should:

- Assess entire visual pathway (not merely individual components).
- Yield objective measures of visual acuity.
- Be easy to administer in low-resource settings without necessitating expensive equipment and specialized training.

- Be suitable for children at 2 years.
- Be quick to administer ( $\leq 10$  minutes/test).
- Possess established validity.

Based on the review of available tests to assess visual acuity and contrast sensitivity in children, and the criteria mentioned above, the Cardiff Acuity Tests and Cardiff Contrast tests were selected as the methods of choice for the visual assessment of the participating children in the follow up study of the INTERGROWTH-21<sup>st</sup> project. In order to meet the challenges of carrying out these assessments in the field, and to enhance the ease of administration, scoring and recoding of results of the tests, it was decided to use a software tool based on portable platforms (such as iPads) to automate certain aspects of the tests.

The measurement of visual acuity and contrast sensitivity in the participant two year olds of the follow up study of the INTERGROWTH-21<sup>st</sup> Project allows us to:

- i. To build a profile of visual function.
- ii. To assess group and individual variability.
- iii. To determine the prevalence and severity of visual impairment in children across groups.
- iv. To determine associations between visual impairment, intra-uterine growth, and postnatal neurodevelopmental and growth outcomes.

## Testing procedure

### Principle

The principle of the Cardiff tests is that of the vanishing optotype. The targets are drawn with a white band bordered by two black bands, each of half the width of the white band, all on a neutral grey background; thus the average luminance of the target is equal to that of the grey background. If the target lies beyond the subject's acuity limit, it merges with the grey background, and simply becomes invisible. Thus resolution, detection and recognition acuity thresholds are all brought together.

The targets used are pictures, all of the same overall size, but decreasing in width of white and black bands. The acuity is given by the narrowest white band for which the target is visible.

The principle of the tests is that of Preferential Looking – a young child will choose to look towards a target rather than towards a plain stimulus. In the Cardiff Test, each target is positioned either in the top half or in the bottom half of the card. If the target is visible, the child will look towards it, and the examiner, watching the child's eye movements, can judge the position of the target from those eye movements. An important feature of the preferential looking technique is that the examiner should not know in advance the position of the target. For any given target width, if the examiner can reliably estimate the position correctly the target is assumed to be visible to the child. If the examiner incorrectly estimates the target

position, or is unable to make a judgement from the child's responses, then the target is assumed to be beyond the child's acuity limit.

The Cardiff test includes three cards at each acuity level, although only two are usually presented. This is so that once one card at a particular acuity level has been presented; the position of the next card to be presented cannot be predicted by either child or examiner.

An up-down rather than right-left separation of targets was chosen so that eye movements are easier to discriminate in conditions of congenital nystagmus. The inclusion of an examiner peep-hole, such as used in conventional grating acuity cards, was avoided as it was found to be unnecessary and also found to sometimes act as a distraction in children at two years of age.

For the purpose of this study, visual acuity will be recorded as Snellen equivalent. However, it is important to note that this does not mean that the same child would be expected to achieve an identical value of acuity on a letter matching or letter reading test. Both grating and Cardiff Preferential looking tests tend to give a higher acuity than a letter test, simply because the child is required only to resolve the target, and not to identify it.

## **Apparatus**

### **The Cardiff Acuity Test**

The Cardiff Acuity Test consists of 3 sets of 11 grey cards with six different pictures familiar to toddlers positioned at the top or bottom of the card (Fig. 1). Each picture's outline is a white band bordered by two black bands and the mean luminance of these bands matches the card's grey background. The pictures are fish, house, train, dog, duck and car. Each acuity level contains three cards with a picture positioned at the bottom of a card, the same picture at the top of a second card and the third card has the picture positioned either at the top or bottom<sup>9, 10</sup>.

### **The Cardiff Contrast Test**

The Cardiff Contrast Test uses the same pictures as the Cardiff Acuity Test, but the pictures all have the same level of detail throughout the test. The outlines that make up the pictures are light and dark grey and these grey levels vary to give lower and lower contrast as the test proceeds<sup>11</sup>.

## **Assessment Kit**

The assessment kit consists of:

1. The Cardiff Acuity and Contrast Cards.
2. Measuring tape.
3. iPad with INTERGROWTH-21<sup>st</sup> Project Vision app.



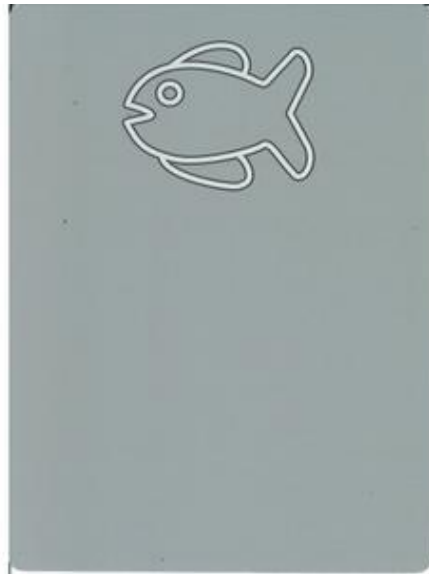


Fig. 1

## Method of Assessment

### Details

Working Distance	50 centimeters
Start card	D
Total number of tests	2 (Cardiff acuity and Cardiff contrast tests)
Duration of administration in clinic	5 minutes (2.5 minutes per test)
Unit for recording visual acuity	LogMar
Unit for recording contrast sensitivity	Contrast sensitivity %

### Procedure

**Step 1:** Explain the procedure to the parent, i.e. tell the parent that you will be showing the child a few pictures to assess the child's vision, and obtain consent

**Step 2:** Load the neurodevelopment application on the iPad and enter the child's FGLS number, date of birth and the researcher code. A neurodevelopment home page for the child will pop up. Access the 'vision' window for the child's neurodevelopment home page. If another

assessment from the package (such as the sleep or neurodevelopment assessment) has been completed already, the child will have a customized neurodevelopment home page already ready and there is no need to create a new one for the same child.

**Step 3:** Request the child to sit on a chair or on his/her parent's lap. The chair must be 50 centimeters away from the researcher. Tell the child that you will be showing him/her a few pictures and that he/she must try and find them on the card.

**Step 4:** Administer the Cardiff Acuity Test as follows.

Beginning with card D, shuffle the three cards and present the first card at the child's eye level, with the centre of the card at your own eye level. In order to maintain the child's attention, talk about the picture, or encourage the child to name or point to the picture. However, in order to ensure a constant procedure amongst children of different ages and levels of understanding, it is important to use ONLY the child's eye movements/positions to establish the acuity limit, and not to use the child's verbal or pointing responses. It is also important to present the card quickly and note the child's immediate response – often a child will glance at the target and then look away and if you are slow in bringing the card up to your eye level, the child will have seen the picture and looked away before you note the eye movements. From the child's eye movements/position, estimate the position (top/bottom) of the target (Fig. 2). Once you have made your decision present the second card; you may then check to corroborate your decisions. If two correct estimates are made, proceed to the next level and repeat along the sequence.

Once an incorrect estimate is made (or no estimate is possible), return to the next LARGER target, and repeat the tests at this and the 'failed' level. At this stage in order to avoid any expectations on the part of the examiner or the child, shuffle the cards between each presentation. The end point should be taken as the highest acuity level at which two out of two presentations are correctly scored.

**Step 5:** Record the child's visual acuity as LogMAR on the visual acuity tab of the 'vision' window of the neurodevelopment application on the iPad. This is done by selecting the visual acuity tab, and then selecting the appropriate LogMar score and Card number using the picker. For the list of LogMar scores and card numbers see Table 1.

**Step 6:** Administer the Cardiff Contrast Test. This is done using a procedure identical to the one described above. The pictures are all of the same overall size to the pictures in the Cardiff Acuity Test, but differ in the contrast difference between the light and dark bands. The contrast sensitivity is given by the lowest contrast for which the picture is visible (contrast sensitivity is the reciprocal of contrast threshold)<sup>11</sup>

**Step 7:** Record the child's contrast sensitivity (%) on the 'contrast sensitivity' tab of the 'Vision' window of the iPad application. The appropriate contrast sensitivity score and card number will

need to be selected using the picker on the application. For the list of contrast sensitivity scores and card numbers see Table 2.



Fig. 2

Card	Picture	Acuity at 1m			Acuity at 50 cm		
		LogMAR	Metres 6/	Feet 20/	LogMAR	Metres 6/	Feet 20/
LVA	Apple	1.2	96	320	1.5	192	640
LVB	Sock	1.1	76	253.4	1.4	152	506.6
A	Fish	1.0	60	200	1.3	120	400
B	House	0.9	48	160	1.2	96	320
C	Boat	0.8	38	127	1.1	76	253.3
D	Train	0.7	30	100	1.0	60	200
E	Duck	0.6	24	80	0.9	48	160
F	Car	0.5	19	63	0.8	38	127
G	Fish	0.4	15	50	0.7	30	100
H	Train	0.3	12	40	0.6	24	80
I	Boat	0.2	9.5	32	0.5	19	63
J	Car	0.1	7.5	25	0.4	15	50
K	Duck	0	6	20	0.3	12	40
L	House	-0.1	4.8	16	0.2	9.5	32
M	Train	-0.2	3.75	12.5	0.1	7.5	25

Table 1 Specification of acuity levels for the Cardiff Acuity Test. The new standard set incorporates cards B to M whilst the Low Vision Set incorporates cards LVA to J.

Card	Contrast % at 50 cm
A	46
B	32
C	22
D	16
E	12
F	8
G	6
H	4
I	3
J	2
K	1.5
L	1

Table 2 Specification of contrast sensitivity levels for the Cardiff Contrast Sensitivity Test.

## References:

1. Gilbert CE, Anderton L, Dandona L, Foster A. Prevalence of visual impairment in children: A review of available data. *Ophthalmic Epidemiology*. 1999; **6**(1): 73-82.
2. Gilbert C, Foster A. Childhood blindness in the context of VISION 2020 —The Right to Sight. *Bulletin of the World Health Organization*. 2001; **79**: 227–32.
3. Holmström G, el Azazi M, Kugelberg U. Ophthalmological follow up of preterm infants: a population based, prospective study of visual acuity and strabismus. *British Journal of Ophthalmology*. 1999; **83**(2): 143-50.
4. Powls A, Botting N, Cooke RWI, Stephenson G, Marlow N. Visual impairment in very low birthweight children. *Archives of Disease in Childhood - Fetal and Neonatal Edition*. 1997; **76**(2): F82-F7.
5. Adams RJ, Mercer ME, Courage ML. A new technique to measure contrast sensitivity in human infants. *Optometry and vision science : official publication of the American Academy of Optometry*. 1992; **69**(6): 440-6.
6. Adams RJ, Courage ML. Using a single test to measure human contrast sensitivity from early childhood to maturity. *Vision Research*. 2002; **42**(9): 1205-10.
7. Teller DY. The forced-choice preferential looking procedure: A psychophysical technique for use with human infants. *Infant Behavior and Development*. 1979; **2**(0): 135-53.
8. Verweyen P. Measuring Vision in Children. *Community Eye Health*. 2004; **17**(50): 27–9.
9. Adoh TO, Woodhouse JM. The Cardiff acuity test used for measuring visual acuity development in toddlers. *Vision Research*. 1994; **34**(4): 555-60.
10. Adoh TO, Woodhouse JM, Oduwaiye KA. The Cardiff Test: A New Visual Acuity Test for Toddlers and Children with Intellectual Impairment. A Preliminary Report. *Optometry & Vision Science*. 1992; **69**(6): 427-32.
11. Associates F. The Cardiff Contrast Test. [Available from: <http://www.cardiffacuity.co.uk/contrast.htm>