Lea Gratings: 253300

In adults visual acuity is measured as “recognition acuity,” which uses standard line tests. This type of test cannot be used in examining infants and children with multiple handicaps. Visual acuity in these individuals is measured with grating acuity tests.

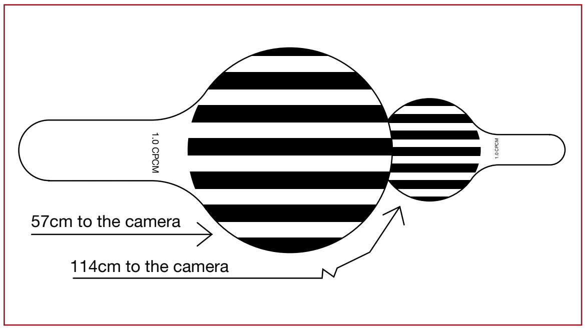
In this grating acuity test, the infant or child detects the presence of parallel lines of decreasing width, a task simpler than recognizing optotypes. When a striped pattern is presented in front of an infant simultaneously with a gray surface of the same size and luminance, the infant is likely to look at the striped pattern because there is more to see than on a gray surface.

The *Lea Gratings* test uses paddles to present gratings. The handle allows the tester to hold the test easily.

The gratings are defined by the frequency, i.e., the number of pairs of black-and-white stripes or cycles, within one degree of visual angle. When grating is printed on a surface, it can be defined also as the number of cycles per centimeter of surface.

When a grating is held at 57cm (~ 2 feet) distance from the infant’s face, one centimeter equals one degree of visual angle. This is a convenient test distance because number of cycles/cm corresponds to grating acuity as cycles per degree.

Infants and children at an early developmental level may not respond to stimuli placed at 57cm distance. Their visual sphere may be limited to less than 3 0cm (~ 1 foot). When the gratings are held at half the 57cm distance, the number of cycles per degree (cpd) is half of that at 57cm. If the infant’s response can be elicited only at 15cm (~ 1/2 foot), 1/4 of the original distance, the frequency of the grating is 1/4 of the value printed on the test. If the child responds to the stimuli at about 1 meter (exactly 114cm or ~ 4 feet), the grating acuity values are twice the value printed on the test.



The 1 cpcm grating is placed at 57cm and at 114cm from the camera. At the 57cm distance the grat-ing is an 1cpd stimulus and at the 114 cm distance the same grating is a 2 cpd stimu-lus. The distance of 57cm is derived from the formula 2 p r. A circle has 360° and the circumference of a circle is equal to 2 p r (where r = the radius). In this case, “r” is equivalent to the distance between the child’s eye and the paddle. If the circumfer-ence of a circle measures 360 cm, then each degree of angle subtends to a distance of 1 cm on the circumfer-ence. The radius of such a circle, r, is then : r = 360cm / 2 p = 57.2cm.

In the examination of infants it is advisable to choose test distances that are parts or multiples of 57cm, i.e. 28cm, 43cm, 85cm or 115cm. Longer distances are rarely used.

Instructions

Make sure the background setting (including your clothing) is either evenly light gray or even dark color to avoid patterns that could distract the infant. If the infant’s visual sphere is limited, the surrounding visual information does not affect the child. However, these children are often disturbed by even weak noises and uncomfortable or unusual body postures.

Start with the coarsest grating. Show the infant the grating simultaneously with the gray stimulus. Then show every other grating in succession. This is made easy by placing the 4.0cpcm grating facing the table, the 1 cpcm grating facing the 8 cpcm grating (which is on the opposite side of the 4 cpcm grating). The top paddle is placed with the 0.25 cpcm grating facing the 2 cpcm grating (on the other side of the 1 cpcm grat-ing). When you have shown a grating place the paddle on the table with the grating facing upwards. This way the grating on the other side of the paddle is ready for presentation.

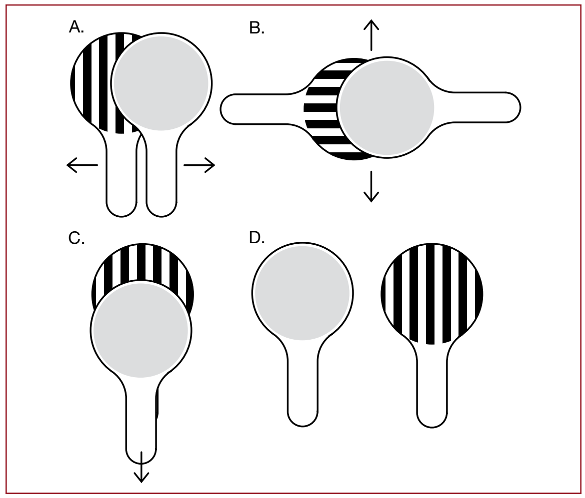
If the infant responds to the 0.25 and the 1.0cpcm grating, but not to the 4.0cpcm grating, present the 2.0cpcm grating. The threshold is found quickly before habituation occurs. If the infant or child seems to lose interest, show a face figure (#253200 Large paddle, or #253100 Medium paddle) or colorful toys to moti-vate him or her to respond again.

Presentation of the Stimuli

The measurement is based on observing the child's eye movements when the grating paddles are presented to the child. The test situation can arranged as a play situation for example so that the parents show the paddles and the child points to the parent who has the grating.

Children with brain damage in the cortical areas that handle motion perception or in pathways leading to these areas may show responses that reveal their abnormal perception of movement. When the grey sur-face and the grating are moved in opposite directions, some children look confused and do not follow the movement of the grating but make a quick shift of gaze to the grating when it stops. This may be a sign of difficulties in seeing moving objects. On the other hand, some children have normal tracking movements, either eye movements or a combination of eye and head movements, but look surprised and confused when the grating stops. They may not have visual functions to perceive objects that stand still. Both obser-vations need to be confirmed in other test situations.

When grating acuity has been measured the result needs to be expressed in cycles per degree (cpd) Some tests express the result as optotype (Snellen) acuity values. In visually impaired children it is impossible to predict what the optotype acuity might be when only the grating acuity can be measured.



Different ways to present the Lea Gratings to children. The grating is kept behind the grey surface while moving it in the midline to the testing distance. When the grating and the grey surface are moved in opposite directions (A-C), motion per-ception is an additional factor in perception of the grat-ing. When the grating and the grey surface are kept motion-less (D) in front of the child, which resembles presentation of Teller Acuity cards, motion perception does not affect the test situation.

Why do we need to use "cycles per degree", why not the visual acuity values?

Grating acuity tests measure function of the visual field in a much larger area than do the optotype tests (letters, numbers, symbols), i.e. the tests measure function of different retinal areas. Recognition of an optotype, except E and C, is a much higher and more demanding visual task than resolving straight lines. The responses come from different functions of the brain. Therefore there is no correct way of converting grating acuity values to optotype acuity values. Physically, resolution of a 30 cpd grating requires the same resolution as an 1.0, 20/20, 6/6 Snellen-E. However, this is true only in normal adult foveal vision, and even there it is not exactly the same. Outside the fovea toward the periphery, grating acuity decreases more slowly than do optotype acuities.

In low vision the relationship between grating acuity and optotype acuity varies as much as: between 1:1 i.e. the two values are equal, and 1:20, i.e. grating acuity is 20 times better than the optotype acuity. Knowing the type of lesion, an experienced clinician can make a fairly accurate guess what the optotype acuity could be. However, the error may be sizeable. Therefore it is not wise to convert grating acuity values into opto-type acuity values.

When explaining the results to people who are not familiar with grating acuity measurements, you can show the grating that the infant or child responded to and say: "As you saw, your child could respond to these fine lines at this distance. This kind of grating is called .. (e.g. 2 cycles per cm, which means that there are two pairs of lines in each centimeter of the surface). When this kind of grating was shown at approximate-ly 57cm distance, there are four lines, two cycles per degree." If you explain grating acuity this well, the people will understand grating acuity much better than they will ever understand optotype acuities. (How many of the readers can explain what a certain optotype acuity value means?)

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What to do when the parents and the fellow teachers do not understand the "cpd"?

They do not understand the optotype acuity value either if you do not show how big an optotype is e.g. a 0.3, 20/63, 3/18 optotype. Similarly, you can show the grating that the infant or child responded to and say: "As you saw, your child could respond to so fine lines at this distance. This kind of grating is called .. (e.g. 2 cycles per cm, which means that there are two pairs of lines in each centimeter of the surface). When this kind of grating was shown at approximately 57cm distance, there are four lines, two cycles per degree."

If you explain grating acuity this well, the parents understand grating acuity much better than they will ever understand optotype acuities. (How many of the readers can explain, what a certain optotype acuity value means?)

What is normal at different ages?

The illustration below shows the range of normalcy at different ages. Values that are clearly below the lower line are highly likely to be deviant (except when the infant or child was tired or fuzzy). Values that are above the upper line are likely to be good normal values. Values within the range of normal are normal but do not mean that vision would be developing normally.

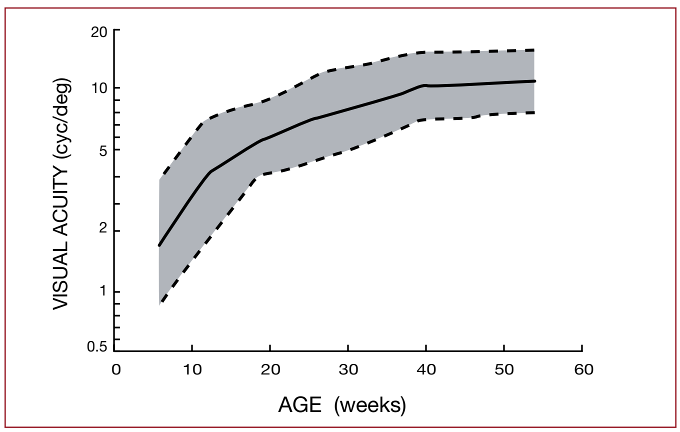
Grating acuity alone is a poor depictor of visual function.

Therefore, never say that the child's vision was measured to be normal. Say that "grating acuity value was within the range of normal, other observations and measurements are needed to give a more complete picture of the child's visual function".

Prerequisites For Measurement Of Grating Acuity

During the measurement of grating acuity, we expect the infant/child to respond with smooth tracking or rapid eye turn to the grating when it is presented. This response requires that:

1. The infant or child sees the grating in that part of the visual field;
2. The infant or child can direct his or her attention to the stimulus;
3. The infant or child has the ability to plan tracking or the saccade toward the target;
4. The infant or child has the motor function of the eye muscles to execute the plan; and
5. The stimulus is presented within the visual sphere of the infant or child.



To evaluate the response correctly, several functions of the infant or child have to be known:

1: Visual Sphere

Use the high contrast face figures to measure how far the stimuli can be moved back before the infant or child loses interest. Always test well within the child's visual sphere.

2: Fixation

The normal response to look at something is to look straight at it, also called "central fixation." If the central part of the visual field is not functioning properly, there is central scotoma. The infant or child uses an extrafoveal area for viewing and seems to look past the stimulus, although actually looking at it. Therefore, it's important to know what kind of fixation the infant or child uses.

3: Visual Field

The infant's visual field is measured previous to the grating acuity measurement. If there is visual field restriction on one side, make sure the gratings are presented within the child's visual field.

4: Saccades

When the infant or child is expected to make a swift saccadic movement as the response, the ability to perform saccades must be present. This is tested with interesting playthings of the same size and interest value presented on both sides of the midline. The infant or child is enticed to look at the tester's face. When the fixation is in the midline, one of the objects is presented at about 20-30cm from the midline, or closer when necessary. Note the latency, speed and accuracy of the saccadic movement. The infant or child is again enticed to look at the tester's face after which the other object is presented on the other side. If there is a difference in the qualities of the saccades toward the two stimuli, motor functions should be evaluated more closely with the child's ophthalmologist after the attentional component is tested.

5: Visual Attention

In children with attention problems, test the symmetry of visual attention at the same time the infant or child is being tested for saccadic movement. If there is asymmetry in the saccadic movement, assess whether the response becomes symmetric by increasing the size of the stimulus on the side of weaker response. For example, present the smallest fixation stick (#253100) on the better functioning side and the medium size stick (#253000) on the less functioning side and observe whether the responses become equal.

In an extreme case, the largest fixation stick (#253200) is used along with the smallest fixation stick before equal saccadic responses are elicited. If the horizontal halves are unequal or when there is horizontal nystagmus, test whether responses to the vertically presented stimuli are more symmetric.

Grating acuity at different distances

On each grating paddle the frequency of the printed grating is given as cycles per centimeter (cpcm). At the distance of 57 cm (22.5"), 1 centimeter equals 1 degree of visual angle*. Thus, only at that distance the cycles per degree value of each grating is equal to the cpcm printed on the paddle. For example, at 57cm, the 0.25 cpcm paddle is equal to 0.25 cpd. When the paddle is brought closer, the number of cycles per degree decreases. When used at a distance longer than 57cm, the number of cpd increases. In the table below, cpd values are calculated at some common distances. If another distance is used, the cpd results can be calculated using this formula:

$$\frac{\text{Distance Used}}{57.2\text{ cm}} \times \text{cpcm} = \text{cpd}$$

*NOTE: This is derived from the formula below. A circle has 360° and the circumference of a circle is equal to 2 p r (where r = the radius). In this case, "r" is equivalent to the distance between the child's eye and the paddle. If the circumference of a circle measures 360 cm, then each degree of angle subtends to a distance of 1 cm on the circumference. The radius of such a circle is then calculated as follows:

$$r = \frac{360\text{ cm}}{2\pi} = 57.2\text{ cm}$$

Grating Acuity Reported in Cycles Per Degree

Distance in CM (Inches)	Cycles Per Centimeter (cpcm): Printed On Paddles					
	0.25	0.50	1.00	2.00	4.00	8.00
29 cm (11.5")	0.12 cpd	0.25 cpd	0.50 cpd	1.00 cpd	2.00 cpd	4.00 cpd
57 cm (22.5")	0.25 cpd	0.50 cpd	1.00 cpd	2.00 cpd	4.00 cpd	8.00 cpd
86 cm (34")	0.40 cpd	0.75 cpd	1.50 cpd	3.00 cpd	6.00 cpd	12.00 cpd