Visual acuity

This article was checked by pedagogue

This article was checked by pedagogue, but more than year ago.

Signature: Carmeljcaruana (talk)

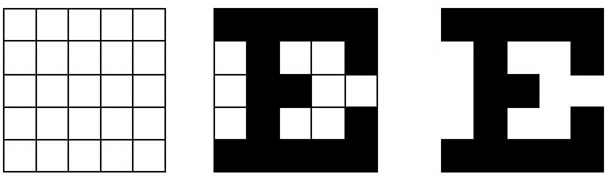
Visual Acuity

The visual acuity (also called *Visus*) is defined as the eye's ability to perceive and resolve fine details of an object and directly depends on the sharpness of the image projected on the retina. Visual acuity is the inverse of the angular size minimum that an object must have in order to be perceived correctly.

Categories

- *Minimum visible* (or sharpness of vision) is the smaller viewing angle within which the eye can distinguish the presence or absence of a stimulus: if an element underlies a visual angle less than the minimum visible, there will be no perception. Physiologically this kind of visual acuity is determined by the stimulation of a single visual photoreceptor, that is illuminated differently from the background so that there is a perception.
- *Sharpness of resolution* (or minimal angle of resolution) expresses the smallest distance between two lines so that are perceived as two separate objects. The minimal angle of resolution presents values much greater than the minimum visible. Theoretically, to detect two distinct lines is necessary to activate two photoreceptors and among them the presence of another non-activated photoreceptor, indicating the lack of continuity. In the normal eye acuity of resolution is about 35-50 seconds of arc.
- *Acuity of alignment or location* is the least perceptible spatial displacement between two figures. It is also called "superacuity" because it reaches very high values. The Vernier acuity is the ability to align two lines between them. The angle expresses the smallest distance between two black bars, so that the subject identifies misalignment. The average value of this type of sharpness is very high i.e 4-5 seconds of arc.
- *Morphoscopic acuity* is the kind of visual acuity more commonly used and better known. Expresses the ability to recognize a particular form among many possible (discrimination), such as a letter of the alphabet. The table that represents the different symbols with different sizes is defined optotypical table and each symbol is defined optotype.

The Snellen chart and the calculation of the optotype's size



Snellen Optotype

The traditional Snellen chart is printed with eleven lines of block letters. The first line consists of one very large letter, which may be one of several letters, for example E, H, or N. Subsequent rows have increasing numbers of letters that decrease in size. A person taking the test covers one eye from 6m away, and reads aloud the letters of each row, beginning at the top. The smallest row that can be read accurately indicates the visual acuity in that eye.

The symbols on an acuity chart are formally known as "optotypes". In the case of the traditional Snellen chart, the optotypes have the appearance of block letters, and are intended to be seen and read as letters. They are not, however, letters from any ordinary typographer's font. They have a particular, simple geometry in which:

- the thickness of the lines equals the thickness of the white spaces between lines and the thickness of the gap in the letter "C"
- the height and width of the optotype (letter) is five times the thickness of the line.

According to Snellen definition, the "normal vision" is the ability of the human eye to recognize an optotype when it subtends 5 minutes of arc and then discriminate a single stroke of the size of 1 arc minute. Visual acuity = Distance at which the test is performed divided by the distance at which the detail of the letter of the test subtends an angle of 1 minutes of arc (and therefore the notation 1 ')

- **AV= Effective Distance/D'**

Observing the formula would be theoretically sufficient a single letter and to vary the distance of the test to obtain different viewing angles, that is, maintain the fixed denominator and the numerator change. Although effective, this procedure in practice it is very inconvenient since it would require very large areas to achieve simultaneously high and low values of visual acuity. Clinically, it is more useful to vary the size of the letters and maintain a fixed distance of the test. Despite this, the formula for the calculation of visual acuity compared to the size of the single optotype remains the same and therefore it can be used calculating for each optotype the distance at which the optotype subtends the same 5 '.

- α = angle subtended by the single optotype's stroke (in first)
- D = distance of the actual test
- H1 = height of the optotype
- H2 = stroke width

AV=1/α tanα=H1/D and the inverse: **α=arctan H1/D**

An optotype is equal to 5 times his single tract. So the single optotype subtends an angle of 5 ': **5H2=H1**

Combining the formulas: **AV=1/arctan(H1/5D)**

It is possible to calculate the visual acuity of an optotype of any size H1 at a particular distance D. Similarly with an inverse formula is possible to calculate the optotype's height to create optoptical tables for any distance: **H1=5Dtan1/60AV**

According to AV=10/10 we will be obtain: **H1=D/687,5**

Physiology

Visual acuity is defined as the ability of the human eye to resolve fine details. To achieve this, the dioptric system of the eye must project an image on the fovea, the central region of the macula which has the highest density of photoreceptors called cones that allow the highest resolution and color vision. Visual acuity and color perception, although they are mediated by the same cells (cones), are physiological functions whose defects are not related. Abnormalities of visual acuity and color are therefore totally independent.

The primary visual cortex is the most posterior (occipital) of the cerebral cortex and is responsible for the first processing of visual stimuli. The ten degrees of central vision (approximately the extension of the macula) are presented in the primary visual cortex (called V1 or area 17) according to the Broadmann's cytoarchitectonic division) from about 60% of the area itself.

Light travels from the fixation point to the fovea through an imaginary line called the visual axis. The structures that the light has to pass through along the visual axis to reach the photoreceptors are in order: the tear film, cornea, anterior chamber, pupil, lens, vitreous humor and nervous layer of the retina. In addition there is the retina pigment epithelium, a dark layer that absorbs light and does not allow light to be reflected within the eye.

What is 10/10 vision?

Tenths (numbers or letters) refer to the board (optotype) that the ophthalmologist makes us read, they are in fact always reduced in size until it reaches the value "standard" of the smallest, that if beds correspond precisely to the ten tenths. So have a view ten tenths means seeing all ten lines of the board, 2/10 only read the first two, 3/10 read the first three rows and so on regardless of the correction made by the lenses that the ophthalmologist position ahead eye. A person who sees ten tenths natural is called "emmetropic", while a person with a mild nearsightedness, farsightedness, or astigmatism (which is called "ametropic"). There are people who can see more of the "canonical" 10/10, also the 12/10, the 14/10 and beyond. 10/10 does not necessarily mean perfect vision. 10/10 vision only indicates the sharpness or clarity of vision at a distance. There are other important vision skills, including peripheral awareness or side vision, eye coordination, depth perception, focusing ability and color vision that contribute to your overall visual ability.

How many megapixels equivalent does the eye have?

It is interesting to make a comparison between the capabilities of the human eye and the technologic devices. The eye is not a single frame snapshot camera. It is more like a video stream. The eye moves rapidly in small angular amounts and continually updates the image in one's brain to "paint" the detail. We also have two eyes, and our brains combine the signals to increase the resolution further. We also typically move our eyes around the scene to gather more information. Because of these factors, the eye plus brain assembles a higher resolution image than possible with the number of photoreceptors in the retina. So the megapixel equivalent numbers below refer to the spatial detail in an image that would be required to show what the human eye could see when you view a scene. Based on the above data for the resolution of the human eye, we can do an example. Consider a view in front of at the eye that is 90 degrees by 90 degrees, like looking through an open window at a scene. The number of pixels would be 90 degrees * 60 arc-minutes/degree * 1/0.3 * 90 * 60 * 1/0.3 = 324,000,000 pixels (324 megapixels). At any one moment, we actually do not perceive that many pixels, but our eye moves around the scene to see all the detail we want. But the human eye really sees a larger field of view, close to 180 degrees. Let's be conservative and use 120 degrees for the field of view. Then we would see 120 * 120 * 60 * 60 / (0.3 * 0.3) = **576 megapixels**, and the full angle of human vision would require even more megapixels!

References

http://webvision.med.utah.edu/book/part-viii-gabac-receptors/visual-acuity/
http://en.wikipedia.org/wiki/Visual_acuity http://www.clarkvision.com/articles/eye-resolution.html
http://www.treccani.it/enciclopedia/tag/acuita-visiva/ http://www.aoa.org/patients-and-public/eye-and-vision-problems/glossary-of-eye-and-vision-conditions/visual-acuity?sso=y http://www.carlobenedetti.it/f-a-q/
http://biomed.science.ulster.ac.uk/vision/-How-is-Visual-acuity-recorded-.html