Dept. of Physiotherapy

Visual optics

Visual acuity

- **Visual acuity** is a measure of the clarity or sharpness of vision.

- **Visual acuity** refers to the sharpness or resolution of visual perception. It is typically assessed by how well one can discern letters, numbers, or patterns at a standard distance.

- It indicates the ability of the eye to perceive fine details and is often assessed using standardized tests.
- Visual acuity is a critical component of eye health and function, reflecting how well you can see details at a specific distance.
- It is commonly tested using charts like the Snellen chart, and results are typically expressed in fractions such as 20/20.
- Regular assessment of visual acuity helps in diagnosing and managing various eye conditions, ensuring optimal vision correction and eye health.

- Visual acuity is often expressed as a fraction, such as 20/20.
- The **numerator** (20) represents the distance at which the test is conducted (in feet).
- The **denominator** (20) represents the distance at which a person with normal vision can read the same line of letters.
- For example, 20/20 vision means that you can see at 20 feet what a person with normal vision can see at 20 feet. A visual acuity of 20/40 means that what you can see at 20 feet, a person with normal vision can see at 40 feet.

Factors Affecting Visual Acuity:

- **Refractive Errors**: Conditions like myopia (nearsightedness), hyperopia (farsightedness), and astigmatism can affect visual acuity.
- **Eye Health**: Diseases such as cataracts, macular degeneration, and glaucoma can impact visual acuity.
- **Age**: Visual acuity can decline with age due to presbyopia, which affects the ability to focus on close objects.

Types of Visual Acuity:

- **Distance Visual Acuity**: Measures how well you see objects at a distance.
- **Near Visual Acuity**: Measures how well you see objects up close, often tested with reading cards or similar tools.

Types of Visual Acuity Charts:

Snellen Chart:

- The Snellen chart is the most commonly used visual acuity test. It consists of letters arranged in rows, with each row featuring letters of decreasing size.
- The test is typically conducted at a distance of 20 feet (6 meters). The smallest line of letters that a person can read accurately determines their visual acuity.
- Results are recorded as a fraction, such as 20/20. For example, 20/40 indicates that what you can see at 20 feet, a person with normal vision can see at 40 feet.

LogMAR Chart:

- The LogMAR (Logarithm of the Minimum Angle of Resolution) chart is designed to provide a more precise measurement of visual acuity than the Snellen chart.
- The LogMAR chart uses letters of equal legibility but arranged in a way that allows for finer gradations of visual acuity. Each row of the chart has letters that are progressively smaller, with each row representing a logarithmic step in visual resolution.
- Results are recorded as a LogMAR value. Lower values indicate better visual acuity. A typical result might be 0.0, which is equivalent to 20/20 vision.

Tumbling E Chart:

- This chart is used primarily for testing the vision of young children, non-English speakers, or people who cannot read letters. It features the letter "E" in various orientations (up, down, left, right).
- The person being tested indicates the direction in which the "E" is pointing. This chart is useful for those who cannot read or understand letters.
- Similar to the Snellen chart, the results are recorded based on the smallest size of the "E" that can be identified correctly.

Jaeger Chart:

- The Jaeger chart is used to measure near visual acuity. It consists of text in various sizes, typically printed in a book or on a card.
- The person reads the smallest text size they can clearly see at a standard reading distance (usually 14-16 inches).
- Results are recorded as Jaeger numbers, where lower numbers indicate smaller text size and better near visual acuity.

Landolt C chart

- It used primarily for assessing the vision of individuals who may not be able to read letters or words.
- It features a series of rings with a small gap, and the task is to identify the direction of the gap
- The Landolt C chart is designed to measure visual acuity by asking the test subject to determine the orientation of the gap in each ring. This method is useful for patients who cannot read letters or symbols, including young children and individuals with certain visual impairments.

Pediatric Charts

- Specialized charts for children often use pictures or symbols instead of letters to assess visual acuity.
- Pediatric charts are specifically designed to assess the visual acuity of children, who may not yet be able to read letters or numbers.
- These charts use various methods to evaluate how well a child can see, and they are typically more engaging and easier for children to understand.
- Children are asked to identify pictures or symbols, which are scaled down in size to test their visual acuity.
- Charts may feature images like animals or objects that are familiar to children.

Types of pediatric charts:

Picture Charts in 3-5 yrs

Tumbling E Chart

- **Description**: The Tumbling E chart uses the letter E in 4 direction. Children are asked to indicate the direction the "E" is facing.
- **How It Works**: The letter E is presented in different sizes and orientations (up, down, left, right). Children point to the direction of the open side of the letter.

Isolated Hand Finger Test

- The **Isolated Hand Finger Test** is a method used to assess visual acuity and ocular alignment in young children, particularly when other standard visual acuity tests may be challenging due to the child's age or developmental level.
- This test can be a practical and effective way to gauge visual function in preschoolers (ages 3-5) who may have difficulty with more complex testing methods.

Sheridan- Gardiner HOTV Chart

The HOTV chart uses the letters H, O, T, and V in various sizes. Children point to the correct letter or match it with a corresponding letter on a card.

- **Example**: The HOTV chart displays these letters in decreasing sizes, making it easier for children who may not yet be able to read.

Picture charts

Description: Picture charts use familiar images or symbols instead of letters to assess vision.

Types:

Allen Pictures: These charts use simple drawings of familiar objects, like an apple, house, or car. Children are asked to identify these pictures from a distance.

- **Example**: The Allen Picture Test features recognizable images, each with a designated size for different visual acuity levels.

Broken wheel test

Children are shown a pair of vehicles, one of which has a wheel cut across like Landolt C, and they are asked to identify which one has the broken wheel. The cars get smaller and smaller.

Light home picture card

The kids are asked to identify the pictures along the lines on a chart that has an apple, a home, and an umbrella arranged in the Snellen equivalents of 20/200–20/10. The test is run at a height of 10 feet.

Vision test in 2-3 yrs

Dot visual acuity test

A lit box with printed black dots of various sizes is presented to the children. The child's level of visual acuity is indicated by the smallest dot found.

Coin test

The youngster is required to identify the two faces of a coin with different sizes printed on it during this test. The child's level of visual acuity is shown by the tiniest dot.

Miniature toy test

When a child sees a tiny toy from ten feet away, they are asked to name or select the pair from the collection.

Vision test in 1-2 yrs

Marble game test

Games that allow children to reach or place can be used to evaluate visual function in 6–12 month olds. Children are requested to fill in the gaps on cards or in boxes with marbles in this activity. This test compares how each child's eye functions when one is closed, rather than attempting to measure the visual acuity of each eye.

Sheridan Ball Test/ Sheridan-Gardiner Test

- visual acuity test specifically designed for young children who may not yet be able to read letters or recognize symbols.
- It is particularly useful for assessing visual acuity in preschool-aged children and those with developmental delays.
- The test uses a series of large, easily identifiable images, often featuring familiar objects or shapes. The Sheridan-Gardiner Test includes images of common objects such as a ball, car, or house.
- A series of images or pictures is presented in decreasing sizes. The child is asked to identify each image as accurately as possible.
- The test is usually conducted at a standard distance, often 10 feet (3 meters), which can be adjusted based on the specific requirements of the test or the child's comfort.

Symbol Charts

Description: Symbol charts use abstract symbols or shapes that children can identify without needing to recognize letters.

Types:

Lea Symbols: These charts use shapes such as a circle, square, triangle, and cross. Each symbol is presented in varying sizes, and children are asked to identify them.

- **Example**: Lea Symbols Chart features these basic geometric shapes at different sizes to test visual acuity.

Landolt C Chart:

This chart features the Landolt C, a ring with a gap in one of four directions. Children indicate where the gap is located.

- **Example**: Landolt C Chart uses rings with gaps oriented in different directions, requiring children to identify the gap location.

Matching Charts

- **Description**: Matching charts involve children matching a symbol or picture from the chart to a corresponding symbol or picture on a separate card.
- **How It Works**: Children are shown a symbol on the chart and must select the matching symbol from a set of cards.

Pediatric Eye Charts with Interactive Elements

Description: These charts incorporate interactive elements to engage young children and make the testing process more enjoyable.

Types:

- **Interactive Digital Charts**: Use touch screens or digital devices where children interact with images or symbols.
    - **Example**: Interactive digital charts might involve dragging and dropping symbols or identifying images on a tablet screen.
- **Story-Based Charts**: Combine visual acuity testing with storytelling or games.
    - **Example**: A chart that tells a simple story or involves a game where children
    - interact with images in a playful context.

Vision test in Infants

optokinetic nystagmus (OKN) test:

- The optokinetic nystagmus (OKN) test is a clinical examination used to assess the function of the vision.
- For the purpose of this test, the infant only has to be awake and have both eyes open.
- According to reports, a newborn's OKN acuity starts at least at 6/120 and gradually increases over the course of the first few months of life, peaking at 6/60 at two months, 6/30 at six months, and 6/6 by twenty to thirty months.

Purpose:

- **Evaluate Eye Movement**: It assesses the ability of the eyes to track moving objects, which can help diagnose various neurological and ocular disorders.
- **Test for Visual Pathways**: It helps evaluate the integrity of the visual pathways from the retina to the brain.

Procedure:

1. **Setup**: The patient is positioned in front of a screen or a moving stripe pattern (often black and white).
2. **Stimulus**: The pattern moves horizontally or vertically. The motion can be continuous or intermittent.

3. **Observation**: The clinician observes the patient's eye movements. A normal response includes a smooth pursuit of the moving stripes followed by a quick reset in the opposite direction (nystagmus).

Responses:

- **Normal Response**: Smooth tracking with a quick phase in the opposite direction indicates intact visual and vestibular systems.
- **Abnormal Response**: Lack of tracking, excessive nystagmus, or nystagmus in one direction may indicate neurological issues, vestibular dysfunction, or eye movement disorders.

Clinical Relevance:

- **Neurological Disorders**: Conditions like multiple sclerosis, brain lesions, or other central nervous system disorders can be diagnosed based on abnormal OKN responses.
- **Vestibular Dysfunction**: The test can help identify problems with the vestibular system, which may contribute to balance issues and dizziness.

Preferential looking test:

The preferential looking test is a psychological method used primarily in developmental psychology to assess infants' visual preferences and perceptual abilities. It relies on the idea that if infants can distinguish between two stimuli, they will look longer at the one they prefer.

Infants up to four months old can use it. According to reports, the range of visual acuity measured using this method is 6/240 in neonates, 6/60 at 3 months, and 6/6 at 36 months.

How It Works:

1. **Setup**: Two different images or scenes are presented side by side.
2. **Observation**: Researchers measure how long the infant looks at each image.
3. **Interpretation**: If the infant looks significantly longer at one image over the other, it suggests a preference or an ability to discriminate between them.

Applications:

- **Cognitive Development**: Assessing infants' understanding of shapes, colors, and patterns.
- **Social Development**: Evaluating preferences for faces or social stimuli.
- **Vision Research**: Understanding visual acuity and perception in early childhood

Visual Evoked Response (VER) test

The Visual Evoked Response (VER) test, also known as Visual Evoked Potentials (VEP), is a diagnostic tool used to assess the functioning of the visual pathways from the eyes to the brain. It measures the electrical activity in the brain in response to visual stimuli.

Infants' visual acuity is 6/120 at 1 month old, increasing to 6/60 at 2 months old, and 6/6-6/12 from 6 months to 1 year old.

How It Works:

1. **Setup**: Electrodes are placed on the scalp to record brain activity. The patient is typically seated in front of a screen.
2. **Stimuli Presentation**: Visual stimuli, such as flashing lights or checkerboard patterns, are presented.
3. **Recording**: The electrical signals generated in the brain in response to these stimuli are recorded by the electrodes.
4. **Analysis**: The recorded responses are analyzed for amplitude and latency, which can indicate the health of the visual system.

Applications:

- **Diagnosing Conditions**: It helps identify issues such as optic neuritis, multiple sclerosis, and other neurological disorders affecting vision.
- **Assessing Visual Function**: It can evaluate the integrity of the visual pathways, especially in patients with unexplained vision loss.
- **Pediatric Use**: In infants and young children, it can assess visual function when behavioral tests are not possible.

Catform drum test

The Catford Drum Test is a visual assessment tool used to evaluate an individual's depth perception and visual acuity, particularly in a clinical setting. It is often utilized in eye examinations to help identify issues with binocular vision or other visual processing problems.

How It Works:

1. **Setup**: The test involves a circular drum with alternating black and white stripes. The drum can be rotated.

2. **Procedure**: The patient is asked to view the drum while it spins. The clinician observes how the patient perceives the stripes and their movement.
3. **Evaluation**: The test assesses the patient's ability to perceive motion and depth. The clinician looks for signs of depth perception deficits or other visual anomalies based on the patient's responses and behavior.

Applications:

- **Depth Perception Testing**: Helps assess how well a person can judge distances and spatial relationships.
- **Visual Acuity Assessment**: Can provide insights into visual clarity and the ability to distinguish patterns.
- **Clinical Diagnosis**: Useful in diagnosing conditions like strabismus (misalignment of the eyes) or other binocular vision issues.

Cardiff acuity card test

The Cardiff Acuity Card Test is a tool designed to assess visual acuity, particularly in young children and those who may not be able to communicate their vision effectively. It is especially useful for testing preschool-aged children.

How It Works:

1. **Setup**: The test consists of a series of cards with different-sized symbols (often using pictures, such as a house or a circle).
2. **Procedure**: The child is asked to look at the cards from a specified distance (usually 3 or 6 meters) and identify the symbols.
3. **Scoring**: The smallest symbols the child can correctly identify determine their visual acuity level.

Applications:

- **Pediatric Vision Assessment**: Commonly used in pediatric ophthalmology and vision screening programs.
- **Monitoring Vision Development**: Helps in tracking visual development over time in children.
- **Identifying Vision Problems**: Aids in detecting issues like amblyopia (lazy eye) or refractive errors early.

Visual acuity for near

Measuring near visual acuity is essential for assessing a person's ability to see clearly at close distances, typically for activities like reading or sewing. Here are some common methods used for near visual acuity testing:

Common Tests:

1. **Jaeger Charts**:
    - **Description**: These charts contain paragraphs of text in varying sizes (Jaeger 1, 2, 3, etc.), with smaller text representing finer acuity.
    - **Procedure**: The patient reads the text from a specified distance, usually around 14 inches (35 cm). The smallest text they can read accurately determines their near acuity.
2. **Snellen Near Card**:
    - **Description**: Similar to the traditional Snellen chart but designed for near vision. It includes letters or symbols sized for close reading.
    - **Procedure**: The patient reads the characters from a distance of 14 to 16 inches. The smallest line read accurately indicates visual acuity.
3. **Reading Cards**:
    - **Description**: Cards with printed sentences or paragraphs designed to test reading ability at near distances.
    - **Procedure**: Patients read the text, and their acuity is assessed based on the size of the print they can read comfortably.
4. **M-Notation**:
    - **Description**: This method uses a metric system to describe near acuity (e.g., M1, M2).
    - **Procedure**: Similar to the Snellen test, but the letters are sized according to the distance (e.g., M1 is readable at 40 cm).

Importance of Near Visual Acuity Testing:

- **Functional Assessment**: Evaluates how well a person can perform daily tasks that require close vision.
- **Identifying Issues**: Helps detect refractive errors, presbyopia, or other visual disorders.
- **Monitoring Changes**: Useful in tracking changes over time, especially in aging populations or individuals with eye conditions.

Using Visual Acuity Charts

- **Testing Procedure**:
    1. **Distance**: For distance visual acuity, the test is usually conducted at a distance of 20 feet (6 meters). For near visual acuity, the test is conducted at a reading distance of 14-16 inches (35-40 cm).
    2. **Lighting**: Ensure that the chart is well-lit and at eye level to avoid skewing results due to poor visibility.
    3. **Occlusion**: One eye is tested at a time, with the other eye covered or occluded to isolate each eye's visual acuity.
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Results:

- The results help determine if corrective lenses are needed and whether any eye conditions might be affecting vision.
- Normal visual acuity is typically around 20/20. Values worse than 20/20 indicate decreased visual acuity, while values better than 20/20 (e.g., 20/15) indicate better than average vision

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Contrast Sensitivity

- Contrast sensitivity refers to the ability of the visual system to detect differences in luminance between objects and their backgrounds.
- It measures how well one can perceive subtle variations in shades of light and dark, rather than just sharp edges or colors.
- This sensitivity is crucial for tasks such as reading, driving at night, and recognizing faces in varying lighting conditions.
- It can be affected by factors like lighting, age, and certain eye conditions.

Types of contrast sensitivity:

Spatial contrast sensitivity

- The term "spatial contrast sensitivity" describes the ability to identify striped patterns at different contrast and spatial frequency levels.
- The patient is asked to determine the minimum contrast at which the bars are characterized as spatial frequency when they are shown sine wave gratings of a parallel light and dark band during the measurement.
- The definition of bar width is defined as spatial frequency, which expresses the number of light-bar pairs and dark bars that extend to an angle of 1^0 at the viewpoint.
- Low spatial frequency denotes large bars high spatial frequency denotes narrow bars.

Temporal contrast sensitivity

- **Temporal contrast sensitivity** refers to the ability to detect changes in contrast over time.
- This aspect of vision is crucial for perceiving motion, flicker, and dynamic changes in the visual environment.
- It measures how well the visual system can process variations in brightness and darkness as they occur in a sequence. It helps in noticing flickering lights or moving objects.
- Similar to spatial frequencies in spatial contrast sensitivity, temporal contrast sensitivity is influenced by temporal frequencies.
- This refers to the rate at which contrast changes occur over time. The human eye is most sensitive to certain temporal frequencies, often around 10-20 Hz.

- Temporal contrast sensitivity is typically assessed using stimuli that flicker or move.
- Tests often present alternating light and dark patterns at varying frequencies, measuring the lowest contrast at which a person can still perceive the flicker or motion.
- Important for activities that involve motion detection, such as driving, sports, and video games.
- It also plays a role in how well one can read rapidly changing information, like scrolling text.

Measurement of contrast sensitivity:

- The threshold level is indicated when the individual is exposed to grating frequencies and contrast below which resolution is impossible; the reciprocal of the contrast threshold determines the contrast sensitivity.
- It is measured by:

$$L_{max} - L_{min} / L_{max} + L_{min}$$

Methods of Measurement

1. Arden grating:

- It has seven plates: six diagnostic plates (number 2) and one screening plate (number 1).
- The contrast ranges across around 1.76 long units, changing from top to bottom
- Viewing the plate at 57 centimeters, the spatial frequency increases from 0.2 cycles per degree to 6.4 cycles per degree, with each cycle being twice as frequent as the previous one.
- Each plate is given a score between 1 and 20 based on how much of it is exposed.
- For a typical person, the sum of six plates with an upper limit of 82 and an interocular difference of less than 12 was established.

2. Cambridge low contrast grating

- This chart is a set of ten spiral-bound plates with gratings included
- The test booklet is six meters away from the wall and must be used to complete the test.
- The pages are arranged in pairs, with one above the other.
- Every pair of pages has the same mean reflectance, but one has gratings and the other is blank.
- The only task for the subject is to select which page—top or bottom—contains grating.
- When the first mistake is committed, the pages are displayed in descending contrast and are stopped.
- A score of 11 is given if plate 10 is error-free. The conversion table is used to highlight the contrast sensitivity based on the patient's overall score over four series.

3. Pelli- Robson contrast sensitivity chart

- The chart shows letters spaced one meter apart and showcasing a 3 degree angle.
- Both sides of the chart are printed.
- Both sides are the same except for a different letter sequence.
- There are two triplets in each line of the chart, which is composed of letters in a certain order.
- From one triplet to the next, the contrast becomes less prominent.
- Between 0.00 and 2.25 is the range of the log contrast sensitivity.
- The chart is hung on the wall so that it may be tested.
- With the use of a light meter, the chart is evenly light so that the white sections' brightness falls between the permissible range of 60 and 120cd/m, which translates to a photographic exposure between 1/15 and 1/30 sec at f/5.6.
- The subject is seated exactly one meter in front of the chart during the recording.
- Each letter on the chart is meant to be named or described by the subject, which begins from the upper left corner and moves horizontally across the line.
- The person is forced to guess, even if they think the letters are invisible.
- When the subject successfully guesses two of the triplet's three letters, the test is over.
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4. Vistech chart

- The sine wave grating chart is utilized three meters away from the subject.
- In this exam, the individual must determine whether the grating is vertical or angled 15 degrees clockwise or counterclockwise.
- Contrast is measured at multiple spatial frequencies.

Factors affecting contrast sensitivity:

1. Age- Contrast sensitivity tends to decline with age due to changes in the eye, such as lens opacity and retinal health.

2. Lighting Conditions- Low-light environments can significantly reduce contrast sensitivity, making it harder to detect objects. Glare from bright lights can also impair sensitivity.

3. Eye Health- Disorders that alter the way light is processed in the eye, such as cataracts, glaucoma, macular degeneration, and diabetic retinopathy, can reduce contrast sensitivity.

4. Refractive Errors- Uncorrected vision issues, such astigmatism or myopia (nearsightedness), can lessen contrast sensitivity, particularly if they cause blurry vision.

5. Visual Acuity- There is a correlation between contrast sensitivity and visual acuity; people with lower contrast sensitivity are typically also less acuously visioned.

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Potential vision

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