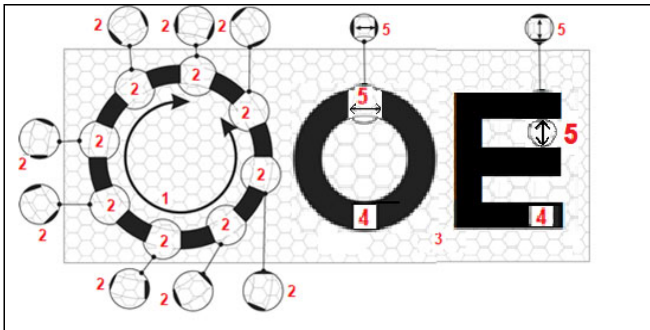
How We See

Dyop® Vision Associates
Allan Hytowitz, 2023-12-28
Allan@dyopvision.com www.dyopvision.com

The eye is a biological machine which enables vision to be both a dynamic **AND** an automatic process. That **dynamic visual acuity** (visual clarity) allows animals to eat rather than be eaten.

A **Dyop** (pronounced "di-op" and short for dynamic optotype) is a spinning segmented ring used as an optotype (visual target) to measure visual acuity (clarity) and refractions. The smallest diameter **spinning** Dyop ring, whose spin **direction** can be detected, is the acuity endpoint (acuity benchmark). At a smaller diameter, the direction of Dyop spinning **CANNOT** be detected (**sub-acuity**). The strobic stimulus of that spinning **Dyop** gap functions as the visual equivalent of an audio tuning fork.



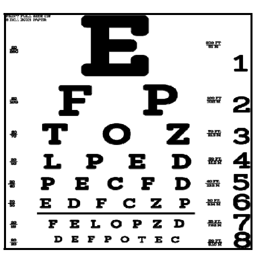
Optotype Components

Item 1 – the visual angular movement/velocity for the strobic contrast response (**40 RPM** optimum) with **a 0.33 arc minute squared per second** refresh rate creating **Resonance Acuity**.
Item 2 – the moving segmented **0.54 arc minute squared** Minimum **Area of Resolution (MAR)** for dynamically stimulating a **20 photoreceptor cluster for Dynamic Acuity**
Item 3 – retinal photoreceptor cell clusters
Item 4 – examples of a historic static **Recognition Acuity** optotypes using gap detection (Landolt) or letter recognition (Snellen).
Item 5 – the static **1.0 arc minute squared** Minimum **Area (MAR)** of a **40 retina photoreceptor cluster** for a historic static optotype

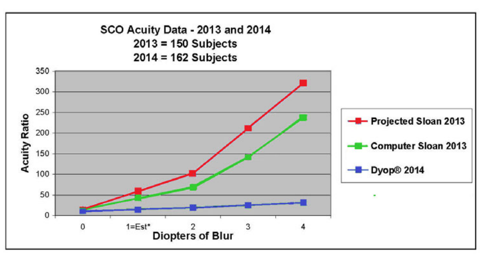
Traditional **Static Visual Acuity targets** (e.g., Snellen letters) use static **Recognition Acuity** (letter detection) based on (**static) gap detection** (e.g., the gap in the letter "C"). Traditional static formats are inherently imprecise, inconsistent, and inaccurate due to the excessively large **estimated Minimum AREA of Resolution (MAR) of 1.0 arc minute squared** for the gap size of the traditional Snellen static stimulus.

The empirically determined **Dyop** stimulus gap **(MAR)** is **0.54 arc minutes squared.** The estimated **Snellen gap (MAR)** is almost twice the area of the empirically determined **Dyop MAR.** That **size disparity** likely explains why Snellen testing has a **logarithmic** increase in size for letter heights and the associated diopters of blur versus the linear relationship between a **Dyop** diameter and diopters of blur.

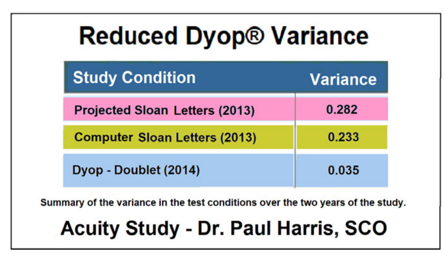
Using static visual targets as optotypes may be a "convenient and simple" method of acuity measurement, but it does not reflect or indicate visual clarity as accurately as using a dynamic visual target. The advantage of using a Dyop for acuity and refraction testing is that it is **up to six times as precise** as Snellen testing, **up to eight times as consistent**, and **up to twice as efficient** as Snellen testing for acuity and refraction measurement. A Dyop retains those advantages regardless of age (such as for children and infants), culture, or literacy of the subject being evaluated, and can be used to **measure acuity in color** for diagnostic purposes as well as potential therapy.



Classic Snellen Test



Dyop Increased precision



Reduced Dyop® Variance

Study Condition	Variance
Projected Sloan Letters (2013)	0.282
Computer Sloan Letters (2013)	0.233
Dyop - Doublet (2014)	0.035

Summary of the variance in the test conditions over the two years of the study.

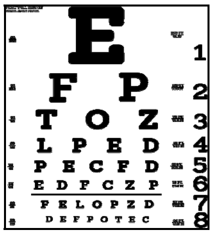
Acuity Study - Dr. Paul Harris, SCO

Dyop Reduced Variance

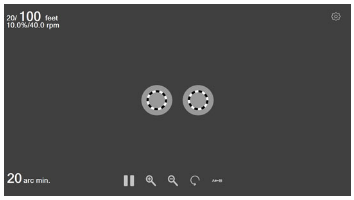
In 1862 Dutch Ophthalmologist Dr. Herman Snellen determined that the use of standardized symbols could provide a functional benchmark for vision. Snellen used European letters and conveniently adjusted the size of those letters to be **5 arc minutes high** (8.8 cm or 3.5 inches) when **viewed at 6 meters (or 20 feet)** with the letter **"E"** as the visual prototype. The **Minimum ARC of Resolution (MAR)** was **1.0 arc minute in height** as the size of the gap between the bars in the letter "**E**. However, that estimated "classic" Snellen gap was actually **1.0 arc minute squared** because letters are two-dimensional with irregular, inconsistent gaps with a **visual stimulus AREA**.

Projected Snellen tests also have inherently fuzzy letters, and typically result in patients preferring an excess spherical acuity of 0.50 diopters or more due to photoreceptor depletion while trying to compensate for the fuzzy letters. The use of Snellen tests, especially projected Snellen tests, by subjects habituated to the use of computerized images, is a possible contributor to the current global “epidemic” of myopia.

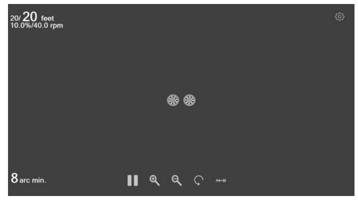
Similar to the use of static (Snellen letters), as the arc width diameter of the spinning Dyop gets smaller, it becomes increasingly difficult to detect the spinning and the spin direction. Sub-acuity is when spinning can NOT be detected. Increasing the Dyops diameter from sub-acuity to the minimum diameter where the direction of spin by the (single) spinning Dyop CAN be detected indicates the acuity endpoint.



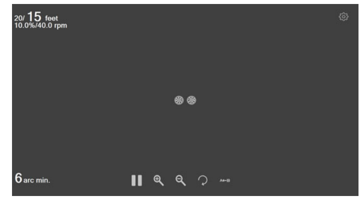
Snellen Acuity



Dyop 20/100 Acuity

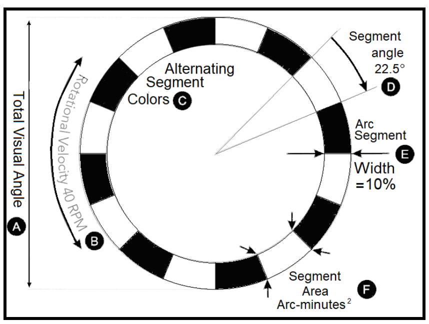


Dyop 20/20 Acuity

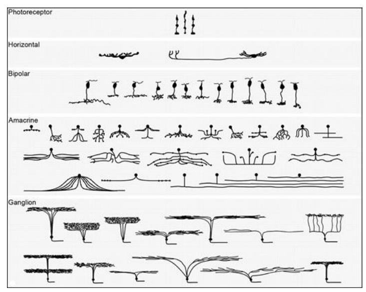


Dyop sub-acuity (20/6)

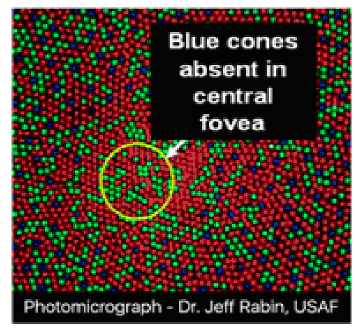
Vision is also a pixilated process. When we think we are seeing lines or shapes or letters or colors, we are actually seeing **pixels** (dots) of light as perceived by the color receptive (cone) photoreceptors. We learn in infancy to combine the response of those pixels into images.



Dyop Components

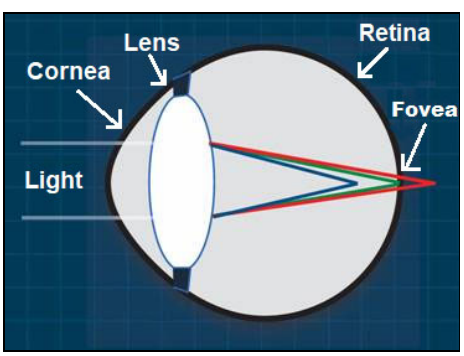


Photomicrograph of neuro-ganglia cells
https://iovs.arvojournals.org/article.aspx?articleid=2188127

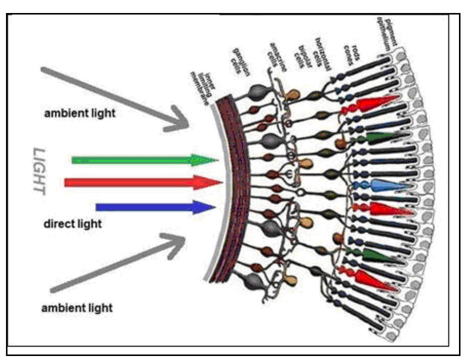


Photoreceptors as Pixels

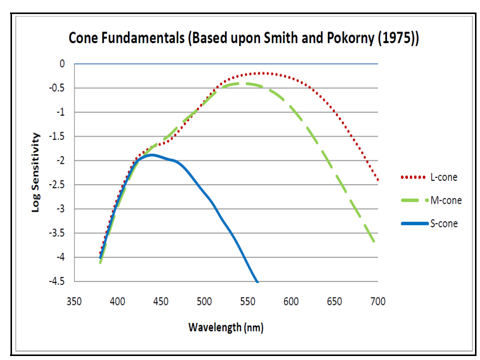
The dynamics of visual acuity is provided by the refresh rate of the photoreceptors. The perception of motion of the spinning Dyop segments/gaps **resonates** with photoreceptor refresh the by constantly changing target stimulus. The color-responsive sensors of the photoreceptors are located in the back of the retina in the area called the fovea, and function much like refresh scanning lines on an electronic display.



Chromatic Triangulation



Light reaching the Photoreceptors



Wavelengths of Light

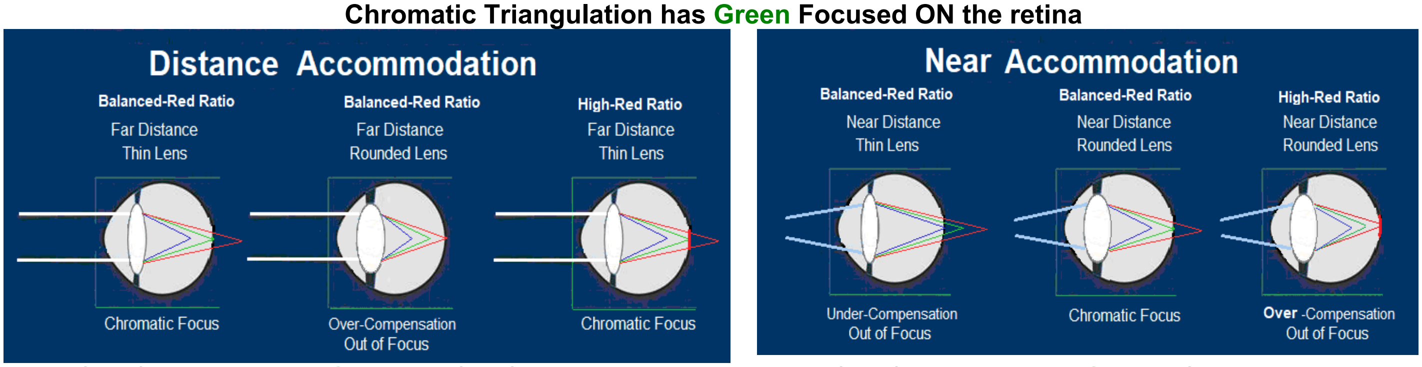
The close proximity of the photoreceptors to each other, enables them to not only respond to the color frequency of light, enables them to sense changes in color intensity, but it enables indications of visual target motion by filtering out ambient light. When direct (emitted light) from electronic devices (the **Stiles-Crawford Effect)** it is perceived at a higher level of intensity. This higher level of intensity perception is due to the **lack** of ambient filtering by the adjacent bodies of the cone photoreceptors as direct light progresses to the rear of the retina.

However, the eye does **NOT** function as a photographic camera taking **static** pictures. Instead, as a **dynamic and autonomic process,** the eye functions much as a video camera taking dynamic pictures which allow that image and focus to be autonomic (functioning without our awareness). The photoreceptor refresh allows the neuro-ganglia cells on the **inner** surface of the retina to function as the biological equivalent of a circuit board and use the constantly changing **Chromatic Triangulation** of the focal depths of blue, green, and red to regulate acuity. Those retina neuro-ganglia cells combine the stimulus of approximately 100 photoreceptors as the matrix stimulus sent to the brain by each optic nerve fiber.

As light enters the **cornea** in the front of the eye, it is bent (**refracted**) to help focus it on the **retina** located in the back of the eye, and is further bent by the adjustable biological **lens** to be more precisely focused on the central **fovea**. As the biological lens adjusts to bend the light, the lens also splits it into colors so that **blue light is typically focused in FRONT of the retina, green light ON the retina, and red light BEHIND the retina.** The result is that when a source of light reaches the fovea, it is perceived with different levels of focal intensity by the blue, green, and red sensitive photoreceptors creating the potential for **chromatic triangulation,** much like the use of triangulation on a map. (By knowing the distance to three adjacent points on that a map, you can determine your location.) By knowing the focal intensity of the blue, green, and red stimulus components of a source of light, you can give that source of light a unique characterization. That **chromatic triangulation** also allows monocular depth perception from the learned recognition of images and sensing of distances based on color expectations even when using only one eye.

Response to colors by the biological lens

Chromatic Triangulation has Green Focused ON the retina



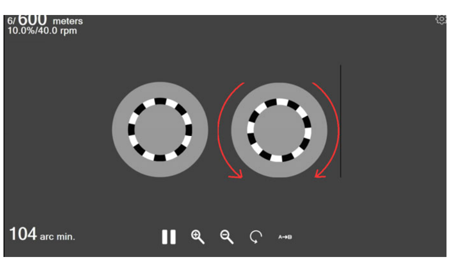
Over-Compensation has Green IN FRONT OF the retina
Stable Near Vision = 50% Red, 45% Green, 5% Blue

Over-Compensation has Green FRONT the retina
Near Vision Stress = 75% Red, 20% Green, 5% Blue

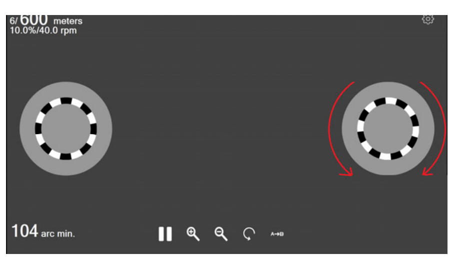
The key to enabling dynamic and autonomic vision is the **refresh rate** of the photoreceptors facilitating the **chromatic triangulation** of the colors of Blue, Green, and Red which are focused at different depths in relation to the retina. Blue is focused in FRONT of the retina. Green is focused ON the retina. Red is focused BEHIND the retina. That **chromatic triangulation** constantly adjusts the shape of the lens to keep the focus of the color Green ON the retina surface. That refresh vibratory effect enables the photoreceptors to function much as the (almost) imperceptible scanning lines on an electronic display to avoid their pixel depletion.

Primary Forms of the Dyop Test.

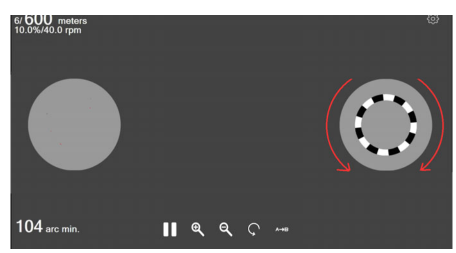
There are numerous formats for using the Dyop as a visual target. The primary formats are the **Adult**, **Children's**, and **Infant** tests.



Adult Dyop Test



Children's Dyop Test

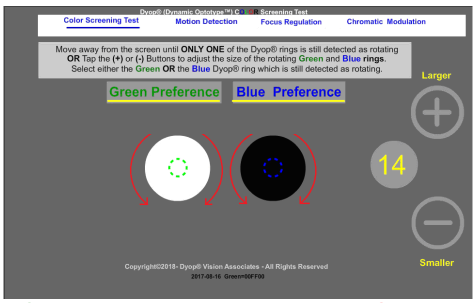


Infant Dyop Test

The **Adult Dyop Test** - (**Keystroke "A")** has two identical diameter Dyop rings near the center of the display with only one spinning ring, creating a choice as to detecting the location of the spinning ring and the direction of spin. The dual ring diameters of the Adult and Children's tests are identical. The visual acuity endpoint is the diameter of the smallest Dyop ring where the direction of spinning was detected. To detect false positives the subject may be asked whether the spinning ring was the left ring or the right ring, or whether that ring was spinning clockwise or counter-clockwise. These tests may also be implemented in color (Blue, Green, Yellow, Red), as well as basic Black/White-on-Gray.

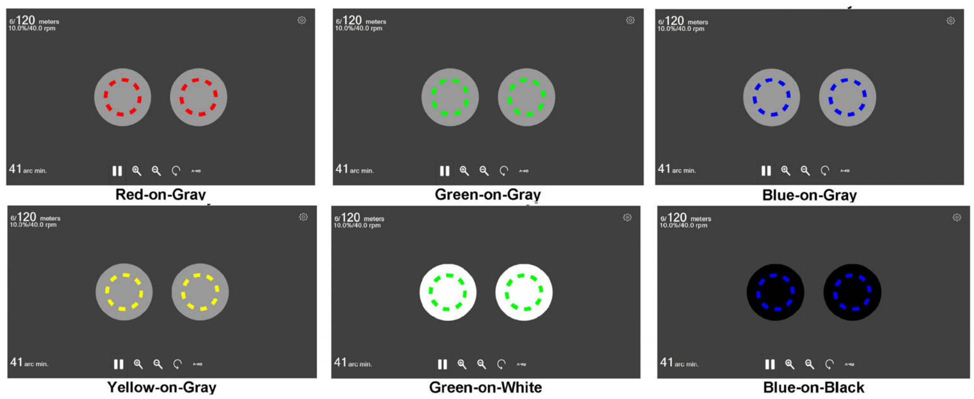
The **Children's Dyop Test** - (**Keystroke "U")** has two peripheral identical diameter Dyops with only one spinning ring. The **Infant Dyop Test** - (**Keystroke "I")** has only **ONE** peripheral Black segmented Dyop on a White background which alternates its peripheral location as the Dyop diameter or spin direction changes. Because of the tendency for preferential motion detection, the **Children's Test** and the **Infant Test** both use tracking the motion of the subjects head and/or eyes to the far right or the far left side of the monitor to track the peripheral location of the single spinning Dyop.

Using remote access software such as **AnyDesk** or **Google Meet** also allows acuity testing to successfully be done regardless of the differences in the computer operating system or distance between the subject and the examiner. Precise **Color Acuity** may be done for contrast sensitivity. Using **Dyop Color Screening** with the Blue/Black Dyop versus the Green/White Dyop may be indicative of potential symptoms of **dyslexia, migraines, or epilepsy**. Where **Near Vision Stress** is indicated by preferentially being better able to see the spinning **Blue/Black Dyop**.



Stable Near Vision vs. **Near Vision Stress**
www.bluegreenscreening.com
www.mydyslexiatest.com

Dyop Color Screening



Dyop Basic Color permutations - Keystroke "Home")

There is also a **Precision Dyop Test -** (**Keystroke "P")** for measuring acuity in 0.04 diopter increments and an **Adjustable Oval Single Dyop -** (**Keystroke "S")** for measuring cylinder and axis on a two-dimensional surface. For specific color responses there is a **Contrast Sensitivity Test** – (**Keystroke "C")** with a standard central Dyop duo and hexadecimal color adjustable Dyop gaps/segments.

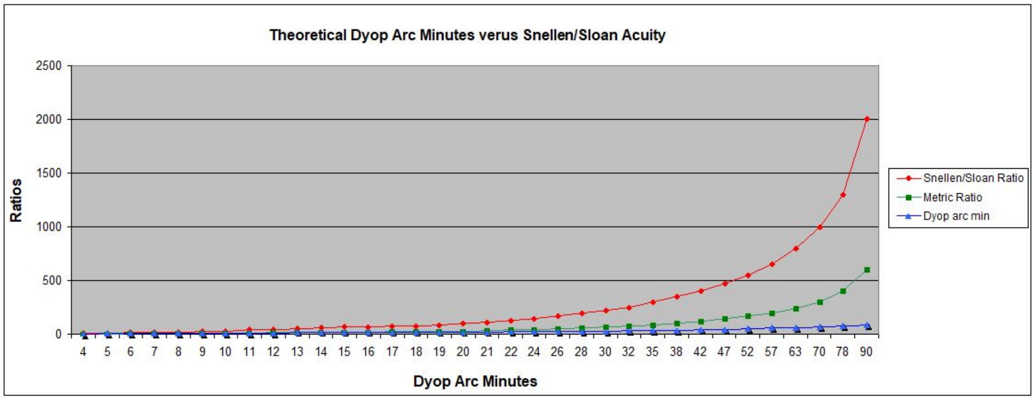
Dyop Advantages versus Snellen for Vision Testing

There are numerous advantages for using a Dyop for vision testing rather than the 1862 Snellen test or similar static optotype. While the **Snellen test**, at the moment, is the global "gold standard" of measuring acuity and refractions, **Static Visual Acuity tests** (such as Snellen) are inherently inconsistent, irregular, and inaccurate.

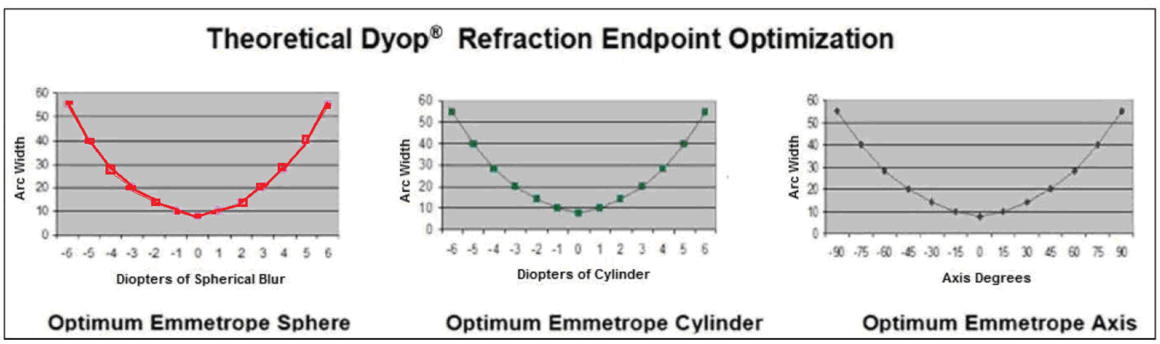
The **First Dyop Advantage** is that a **Dyop** utilizes **Dynamic Visual Acuity.** The world we live in is dynamic rather than static. A spinning Dyop resonates with the refresh rate of the photoreceptors to reduce the photoreceptor depletion response (burn out) caused by stimulus fixation. An example of fixating on static targets is a fighter pilot attempting to track the location of an enemy plane by staring at it. Instead, the enemy plane disappears due to that photoreceptor depletion response. That photoreceptor refresh is also akin to the scanning lines of (colored) pixels constantly moving across a **computer monitor or similar electronic devices** (typically at about 60 cycles per second) which keeps that image refreshed and dynamic. Fixation on static visual targets, such as Snellen, inherently overminus acuity and refractions by 0.25 to 0.50 diopters or more.

The **Second Dyop Advantage** is that the photoreceptors see images as a two-dimensional **AREA** and not as a one dimensional **ARC** (or function of height) as typically measured by Snellen letters. The Snellen stimulus is also **NOT** 1.0 **ARC** MINUTES but is an **AREA** of 1.0 **arc minutes squared.** However, the actual **empirically determined Minimum AREA of Resolution (MAR) is NOT the Snellen 1.0 arc minutes squared**, but is the **MAR** of the "**optimum Dyop**" of **0.54 arc minutes squared AREA** which is comparable to the 20/20 (6/6) Dyop acuity with an optimum angular Dyop diameter of 7.6 arc minutes, a 10% stroke width, and a 40 RPM rotation rate. The "**imprecise" 1.0 arc minutes squared Snellen MAR,** and the dependence on **Recognition Acuity** inherent in the **Snellen** test, contribute to the Snellen imprecision and increased variance versus Dyop testing. Typical **Resolution Acuity** tests use the ability to perceive the separation of a gap or two points such as stars, rather than Snellen-type **Recognition Acuity.** However**, some Resolution Acuity** tests such as the Landolt C or Tumbling E are equally as imprecise and inconsistent as Snellen because they are also based on the assumed Snellen **1.0 arc minute squared MAR**. The result of the smaller **Dyop** stimulus gap, and the reduced photoreceptor depletion, is that Dyop testing is up to six times more precise, up to eight times more consistent, and up to twice as efficient as Snellen testing.

The **Third Dyop Advantage** is that Dyop tests have a linear increase in size versus diopters of blur rather than the Snellen logarithmic ratio of height to diopters of blur (aka, the **LogMAR** concept). That disparity is likely due to the Snellen **MAR** being about twice the area as the Dyop **MAR**. This allows the linear Dyop diameter-to-diopters ratio to provide a **far more precise, consistent, and convenient ability to test for Low Vision**. That disparity is the reason that **LogMAR** is as much a measure of the inherent Snellen error as it is of acuity.

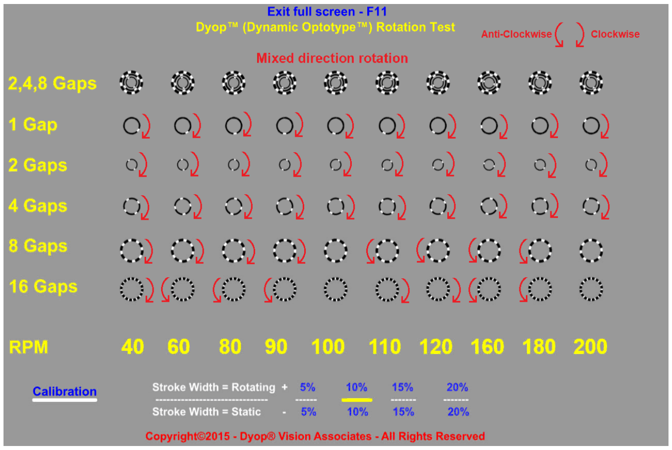


A **Fourth Dyop Advantage** is that a Dyop optimizes a refraction to create optimum sphere, axis, and cylinder values for the acuity endpoint where a **sub-acuity** setting (direction of spin **NOT** detected) lets the Dyop diameter be increased to detect its spinning as the acuity endpoint for that refraction variable.

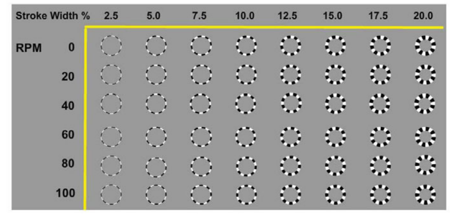


The **Fifth Dyop Advantage** is that a Dyop validates the dynamic nature of visual processes. The "**optimum Dyop**" 40 RPM rotation rate creates an empirically derived refresh rate for a photoreceptor of about 0.33 arc minute squared per second. The theoretical increase in rotation of a typical visual target produces a solid image known as **Flicker Fusion**, however as the speed of a Black/White-on-Gray Dyop rotation increases (8 gaps + 8 segments), it creates a threshold perception of its being stationary (**Flicker Resonance)** at 100 RPM rather that of a solid Gray ring. Rotation speeds **above 100 RPM** create the perception of retrograde spinning. (It also explains the retrograde apparent motion of a speeding hubcap as the result of the photoreceptor refresh rate.)

Further validating the dynamic nature of vision is that a Dyop with **16 gaps and 16 segments Dyop,** with a 10% stroke width, doubles the stimulus rate. That 16x16 Dyop stimulus result has a 50 RPM stationary threshold. Increasing the rotation rate of the 16x16 Dyop above **50 RPM** creates the perception of retrograde spinning with static thresholds (**Flicker Resonance**) at increments of **50 RPM.** Further increases in the rotation speed above **100 RPM** reverse the retrograde perception again so that the rotation appears "normal" until the rotation speed reaches above **150 RPM** with retrograde motion again until it appears static again at **200 RPM**.



Static image of the rotation/retrograde threshold of a Dyop at graduated rotation rates.
https://www.dyop.net/documents/Colenbrander-Overlap.swf.html



SW % RPM	2.5% SW	5.0% SW	7.5% SW	10.0% SW	12.5% SW	15.0% SW	17.5% SW	20.0% SW
0 RPM	10.7	8.2	7.7	7.0	6.7	6.5	6.5	6.3
20 RPM	9.7	8.4	8.1	7.9	7.9	8.1	8.2	7.7
40 RPM	9.5	8.2	8.2	7.6	7.7	7.9	7.7	7.7
60 RPM	10.6	9.1	8.6	8.4	8.1	8.1	8.1	8.1
80 RPM	12.1	10.3	9.9	9.1	8.1	8.6	8.4	8.4
100 RPM	13.9	11.4	10.5	10.3	10.1	9.1	9.1	8.9

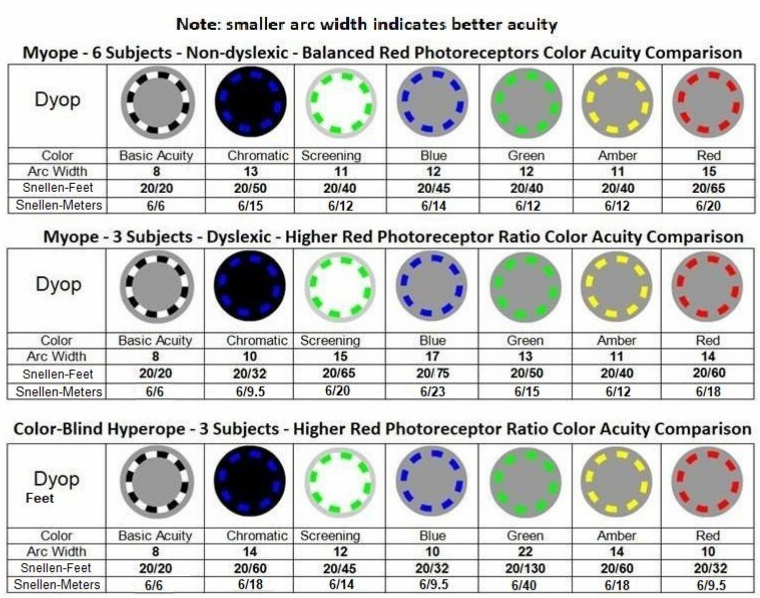
The Optimum Dyop acuity endpoint (smallest arc width for a spinning Dyop) is 40 RPM with a 10% Stroke Width

Flicker Resonance uses Dynamic Resolution Acuity, similar to an audio tuning fork where the optimum strobic stimulus of a Dyop resonates with the refresh rate of the photoreceptors. The empirically derived refresh rate of the photoreceptors (40 rpm with a 10% stroke width) is about 0.33 arc minutes squared per second as determined from the retrograde motion thresholds as the Dyop rotation rate increases.

The **Sixth Dyop Advantage** is that a Dyop minimizes the problem of Snellen induced-myopia from the 21st century habituation to the extra crispness of electronic images (aka the **Stiles-Crawford Effect**). During the 300,000 years since the basic development of the eye, the eye was primarily exposed to ambient/scattered light. However, 21st century technology has been both a blessing and a curse as to visual processing. The light sensitive areas of the photoreceptors, located at the rear of the retina, enabled them to be more sensitive to the direction and motion of the light source. What has changed in the 21st century is that much of the light we now see is emitted (direct) light from electronic sources such as computer displays, smart phones, and LED lights**),** making the photoreceptors hyper-sensitive to the direct stimulus of emitted electronic sources of light (the **Stiles-Crawford Effect**). As a result, the eye not only is habituated to the extra crispness of such light, but when exposed to a continuous stimulus, the emitted light tends to deplete the ability of the photoreceptors to respond.

The **Seventh Dyop Advantage** is that the Snellen concept is based on a Black/White indicator of acuity and blatantly ignores the fact that the majority of people see their world in color. Measuring acuity in color may explain numerous visual anomalies as well as lead to significant visual therapies.

Color acuity endpoint based on vision type



Note: smaller arc width indicates better acuity

Myope - 6 Subjects - Non-dyslexic - Balanced Red Photoreceptors Color Acuity Comparison

Dyop							
Color	Basic Acuity	Chromatic	Screening	Blue	Green	Amber	Red
Arc Width	8	13	11	12	12	11	15
Snellen-Feet	20/20	20/50	20/40	20/45	20/40	20/40	20/65
Snellen-Meters	6/6	6/15	6/12	6/14	6/12	6/12	6/20

Myope - 3 Subjects - Dyslexic - Higher Red Photoreceptor Ratio Color Acuity Comparison

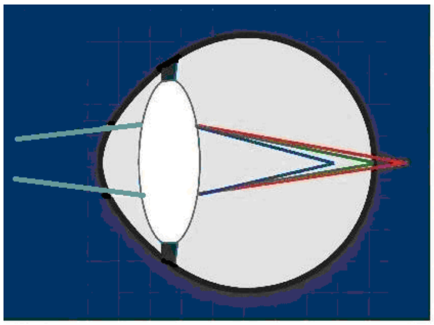
Dyop							
Color	Basic Acuity	Chromatic	Screening	Blue	Green	Amber	Red
Arc Width	8	10	15	17	13	11	14
Snellen-Feet	20/20	20/32	20/65	20/ 75	20/50	20/40	20/60
Snellen-Meters	6/6	6/9.5	6/20	6/23	6/15	6/12	6/18

Color-Blind Hyperope - 3 Subjects - Higher Red Photoreceptor Ratio Color Acuity Comparison

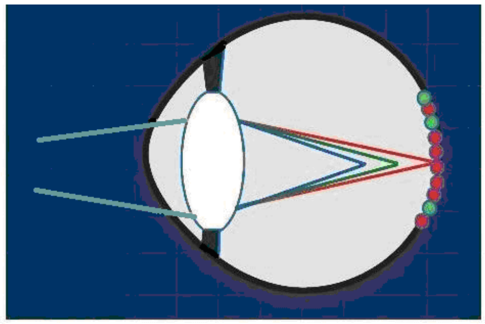
Dyop Feet							
Color	Basic Acuity	Chromatic	Screening	Blue	Green	Amber	Red
Arc Width	8	14	12	10	22	14	10
Snellen-Feet	20/20	20/60	20/45	20/32	20/130	20/60	20/32
Snellen-Meters	6/6	6/18	6/14	6/9.5	6/40	6/18	6/9.5

https://www.dyop.net/documents/Color_Contrast-patterns.jpg

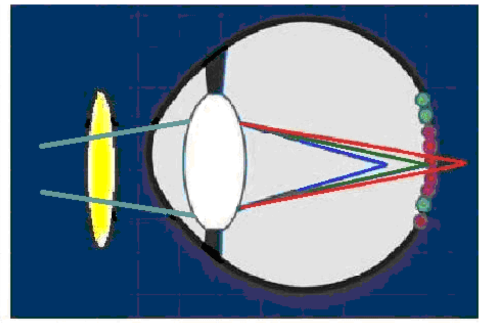
Snellen ignores the visual perception disparities associated with differences with the ratio of red, green, and blue photoreceptors. The photoreceptor refresh allows the neuro-ganglia cells on the **inner** surface of the retina to function as the biological equivalent of a circuit board and use the constantly changing **Chromatic Triangulation** of the focal depths of blue, green, and red to regulate acuity. **Near Vision Stress** has a higher ratio of red/green photoreceptors (**75% red** and **20% green**) seems to be almost always associated with hyperopia and dyslexia. A **Stable Near Vision** has a more balanced red/green ratio (**50% red** and **45% green**). Unfortunately, **Near Vision Stress** also seems to be associated with potential symptoms of dyslexia, migraines, and epilepsy due to the near vision instability.
https://www.dyop.net/documents/Dyslexia_and_Color_Perception-SandraStark.pdf



Stable Near Image
50% Red and 45% Green photoreceptors



Near Vision Stress
75% Red and 20% Green photoreceptors



Chromatic Modulation
Chromatic filter shifts the perceived focus

The higher ratio of red/green photoreceptors leads to Near Vision Stress.

The **Eighth Dyop Advantage** is that a Dyop helps to explain that **acuity is NOT** a "**Black Box.**"
https://www.sciencedirect.com/science/article/abs/pii/S0002939420306620?dgcid=rss_sd_allhttps://www.sciencedirect.com/science/article/abs/pii/S0002939420306620?dgcid=rss_sd_all

Instead, acuity is a learned and visually-programmed response and is regulated by the photoreceptors. The empirically derived **Dyop MAR** of **0.54 arc minutes squared** correlates to an **AREA** of approximately **20 photoreceptors (~200,000 photoreceptors/mm^2)** as a **MAR cluster.** Each optic nerve fiber in turn combines the processed neural ganglia response of about 100 photoreceptors, or five **MAR clusters**. As the visual stimulus moves across the retina, the neural ganglia combine the matrix responses of **five MAR clusters (of 20 photoreceptors each) for each optic nerve fiber** to indicate the color and motion perception of the stimulus to determine the stimulus each optic nerve fiber sends to the brain, and determines the stimulus sent to the muscles of the biological lens to coordinate its focal depth of red, green, and blue to autonomically keep the desired image in focus. The layers of the neural ganglia functions much as a **biological circuit board** interpreting that photoreceptor stimulus to benchmark the **Chromatic Triangulation** for the refractive color focal depths.

The **Ninth Dyop Advantage** is that a Dyop's inherent increased precision helps to explain the disparity between "subjective" optotype refractions with a phoropter (or Trial Lens Frame Kit) versus "objective" refractions with Autorefractors. The biological basis for "subjective acuity" has **photoreceptors in the REAR of the retina** so that the elongated bodies of the photoreceptor cells filter ambient light and enable the indication of the direction of motion of a visual target by the photoreceptor **MAR clusters**. Despite their seeming precision, a**utorefractors measure acuity by reflecting light off of the INNER surface of the retina**, rather than the rear surface where the photoreceptor sensors are located. Fortunately, the increased precision and efficiency of Dyop testing compensates for the illusion of autorefractor efficiency.

Note 1: This discussion is primarily concerned with how the eye sees as to acuity (clearness of vision). There are other types of photoreceptors in the retina called rods (due to their shape) which are sensitive only to the general intensity of light. The rods are on the (inside) surface of the retina, but typically outside of the fovea area.

Note 2: This discussion does not include amblyopia, strabismus, the need for prism, or the functioning of the iris as a pigmented muscular curtain located between the cornea and the biological lens. The center of the iris is an opening called the pupil. The adjustable size of the pupil regulates the overall amount of light entering the eye.

Dyop Test Options (and associated keystrokes for test initiation)
Adult Test – Keystroke "A" - standard central duo – Black/White on Gray
Children's Test - Keystroke "U" - separated peripheral duo – Black/White on Gray
Infant Test - Keystroke "I" - alternating peripheral single – Black on White
Contrast Sensitivity Test – Keystroke "C" - standard central duo – Color Adjustable Gaps/Segments
Single Dyop Test – Keystroke "S" - single central Dyop – Black/White on Gray
Precision Test - "P" - Keystroke Dyop duo w/ smaller increments size changes – Black/White on Gray
Patient Wizard Tests – Keystroke "W" - group of automated Dyop test w/ multiple formats and Color options

Additional Dyop References
Dyop illustrative video: https://chart2020.com/dyop/
Dyop simple explanation: https://www.dyop.net/documents/Dyop_Simple_Explanation.pdf
Dyop/Snellen comparison: https://www.dyop.net/documents/Which_Optotype_Are_You_Using.pdf
Dyop vs., Tumbling E: https://www.dyop.net/documents/Dyop_vs_Tumbling_E_Visual_Acuity_Screening.pdf
Dyop Test Instructions: https://www.dyop.net/documents/Dyop_Test_Instructions.pdf
Dyop iPad Instructions" https://www.dyop.net/documents/Dyop_iPad_Test-Instructions.pdf
Dyop Users Guide: https://www.dyop.net/documents/Dyop_UsersGuide.pdf
Dyop Refraction Procedure: https://www.dyop.net/documents/Dyop_Refraction_Procedure.pdf
Dyop Proof-of-Concept: https://www.dyop.net/documents/Cyclops-Worlds_Largest_Visual_Acuity_Test.pdf
Dyop Origin: https://www.dyop.net/documents/Origin_of_Dyops.pdf

Dyop Research:
https://www.dyop.net/documents/Snellen_vs_Dyop-Cataracts_Gordon.pdf
https://www.dyop.net/documents/Snellen_vs_Dyop_Refractions-Sanni.pdf
https://www.dyop.net/documents/Dyslexia_and_Color_Perception-SandraStark.pdf
https://www.dyop.net/documents/Infant_Acuity_Test_Proof-of-Concept.pdf
https://www.dyop.net/documents/Dyop_vs_Tumbling_E_Visual_Acuity_Screening.pdf
https://www.dyop.net/documents/AAPOS-poster_2021-02-28-Barnettt-Itzhaki.pdf
https://www.dyop.net/documents/17-The_DYOP_visual_acuity_test_for_use_in_children_Barnett-Itzhaki.pdf
https://www.dyop.net/documents/05-Optimal_Dyop_rotation_speed_for_maximum_visual_acuity_Paritzky-Gantz.pdf
https://www.dyop.net/documents/ASOP-2022-01_Sanni-update.pdf
https://www.dyop.net/documents/JCOVS-21-Gordon_refraction_comparison.pdf
https://actascientific.com/ASOP/pdf/ASOP-06-0651.pdf
https://www.oepf.org/wp-content/uploads/2021/01/OVP-11-2_Use-of-Dyop-Colors-Test-for-Color-Acuity-Assessments.pdf
https://actascientific.com/ASOP/pdf/ASOP-05-0516.pdf

Trial Dyop Tests
https://chart2020.com/dyop-download-form/
https://chart2020.com/chart2020-pro-trial-form/
https://chart2020.com/trial-research/