The Origin of the Dyop®

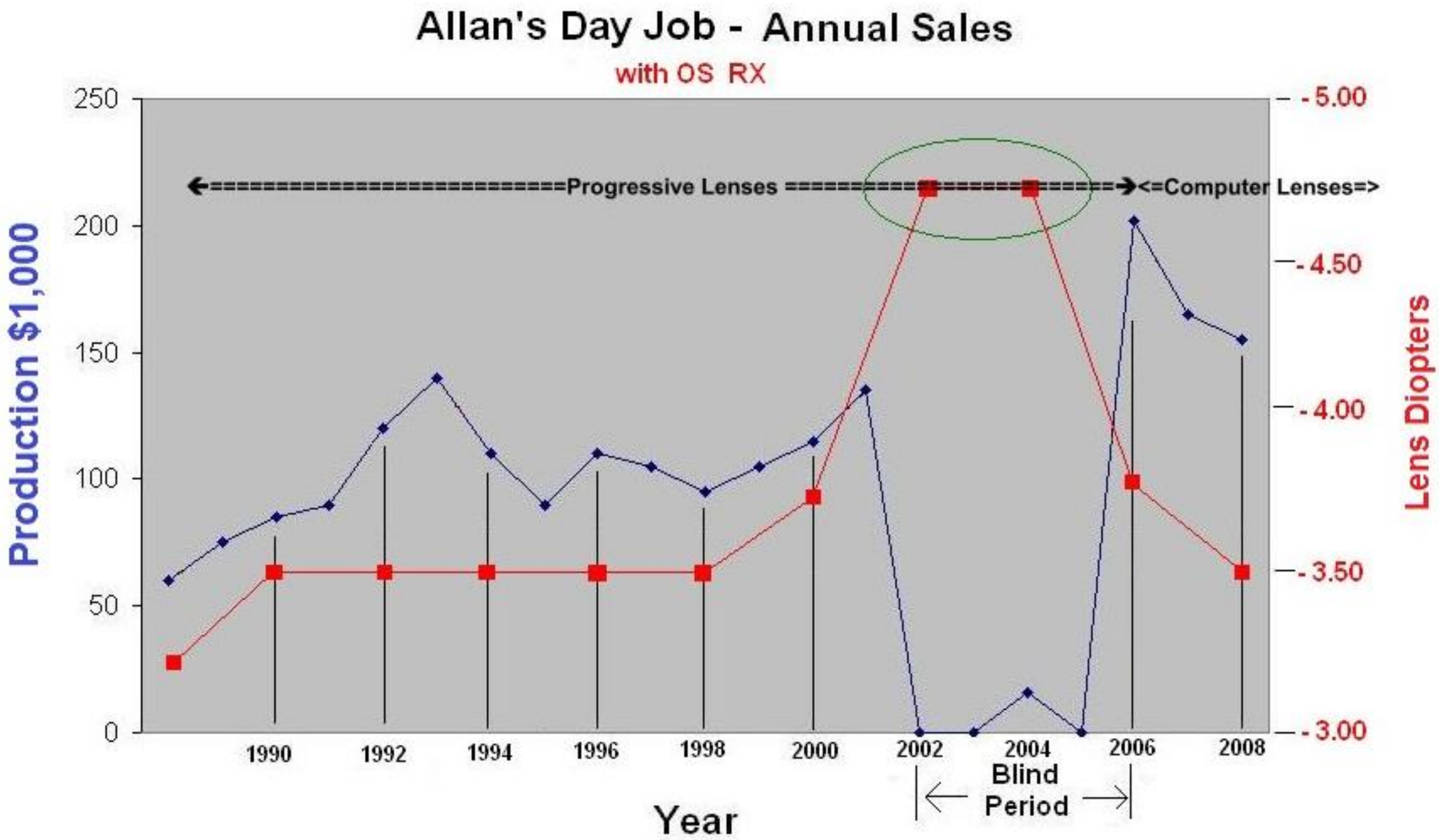
Allan Hytowitz

(N=1)

Helping the world see more clearly, one person at a time.

Allan's Mystery

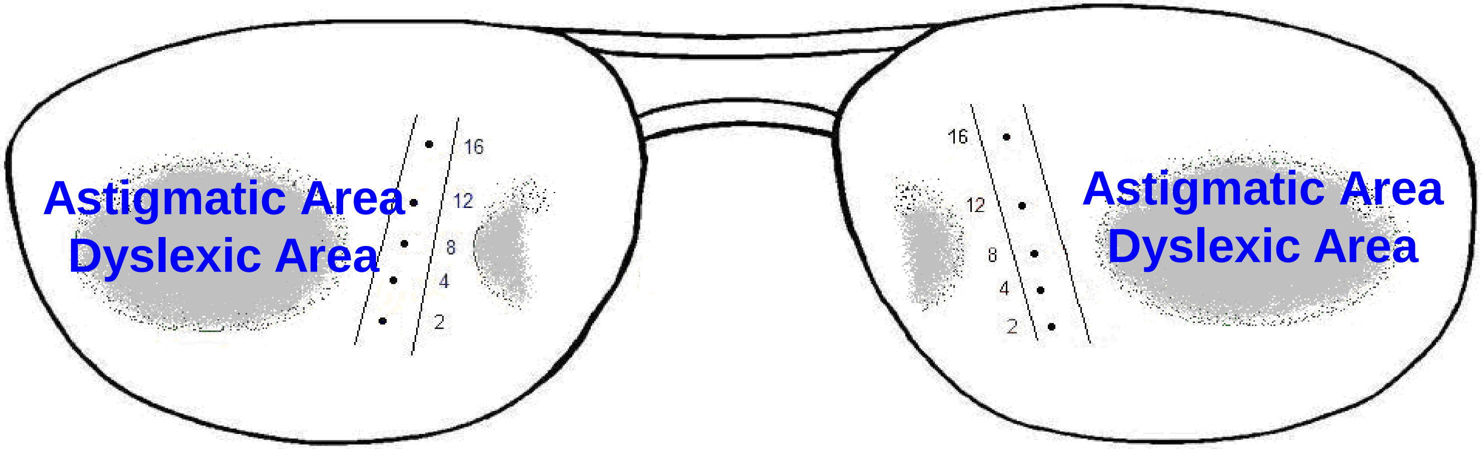
Allan's Discovery



Allan's Discovery

Inherent Vision Loss with Progressive Lenses

Dyslexic Areas caused blurry and distorted vision and almost four years of functional blindness



Allan’s Discovery

Allan’s view with Computer Lenses

Clear and “coherent”

Olny srmat poelpe can raed tihs.

The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, is taht it deosn't mttaer in waht oredr the lterets in a wrod are, the olny iprmoatnt tihng is taht the frist and lsat lteetr be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteetr by istlef, but the wrod as a wlohe.

Allan's Discovery

Allan's view with Progressive Lenses

Unclear and "incoherent" from tunnel vision

Olny srmat poelpe can raed tihs.

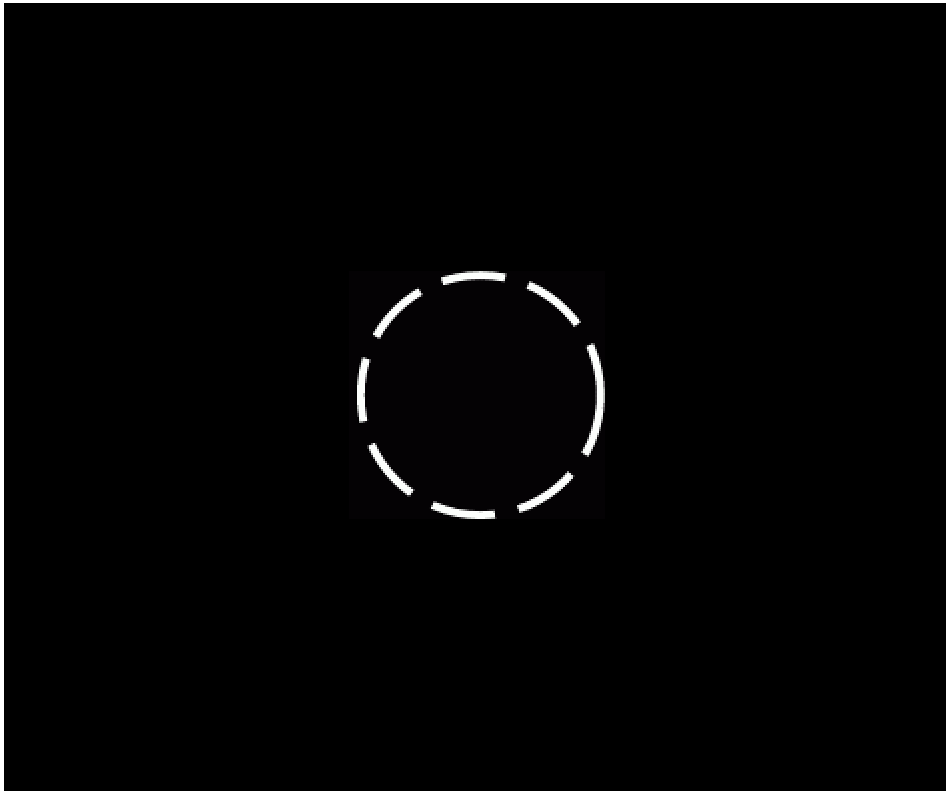
The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, is taht it deosn't mttaer in waht oredr the lterets in a wrod are, the olny iprmoatnt tihng is taht the frist and lsat lteetr be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteetr by istlef, but the wrod as a wlohe.

Allan’s Original Vision Test Device

Spinning LED’s turned blurry in the peripheral areas

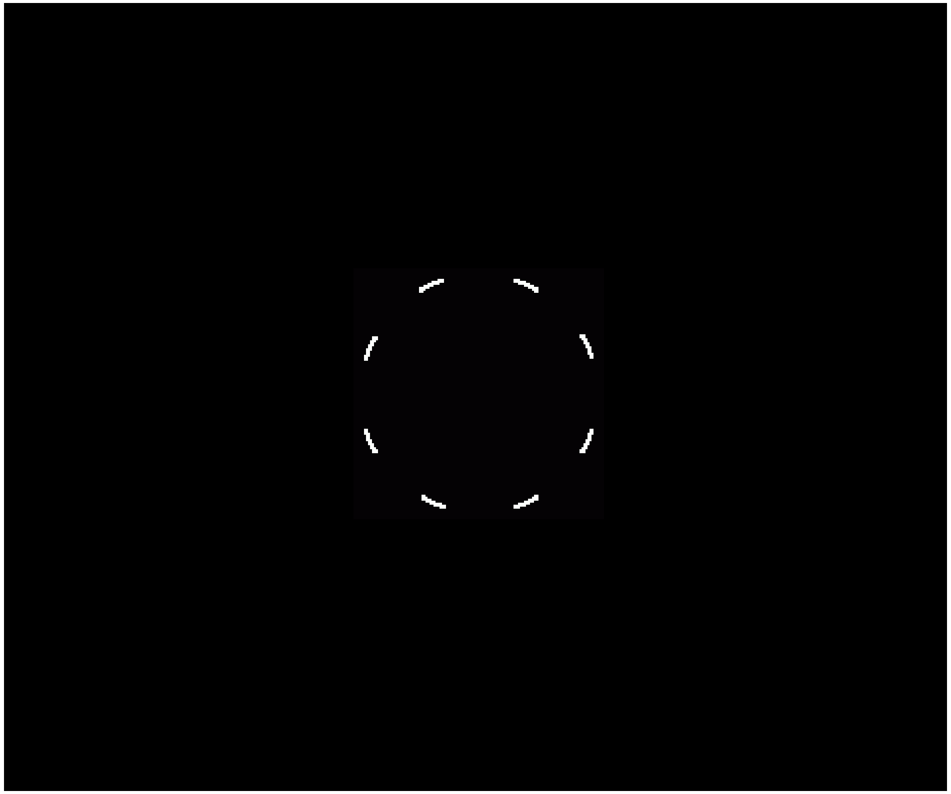
“Rotating Segmented Circles”

Early attempts to create a rotating image



“Rotating Segmented Circles”

Early attempts to create a rotating image (100 hours later)

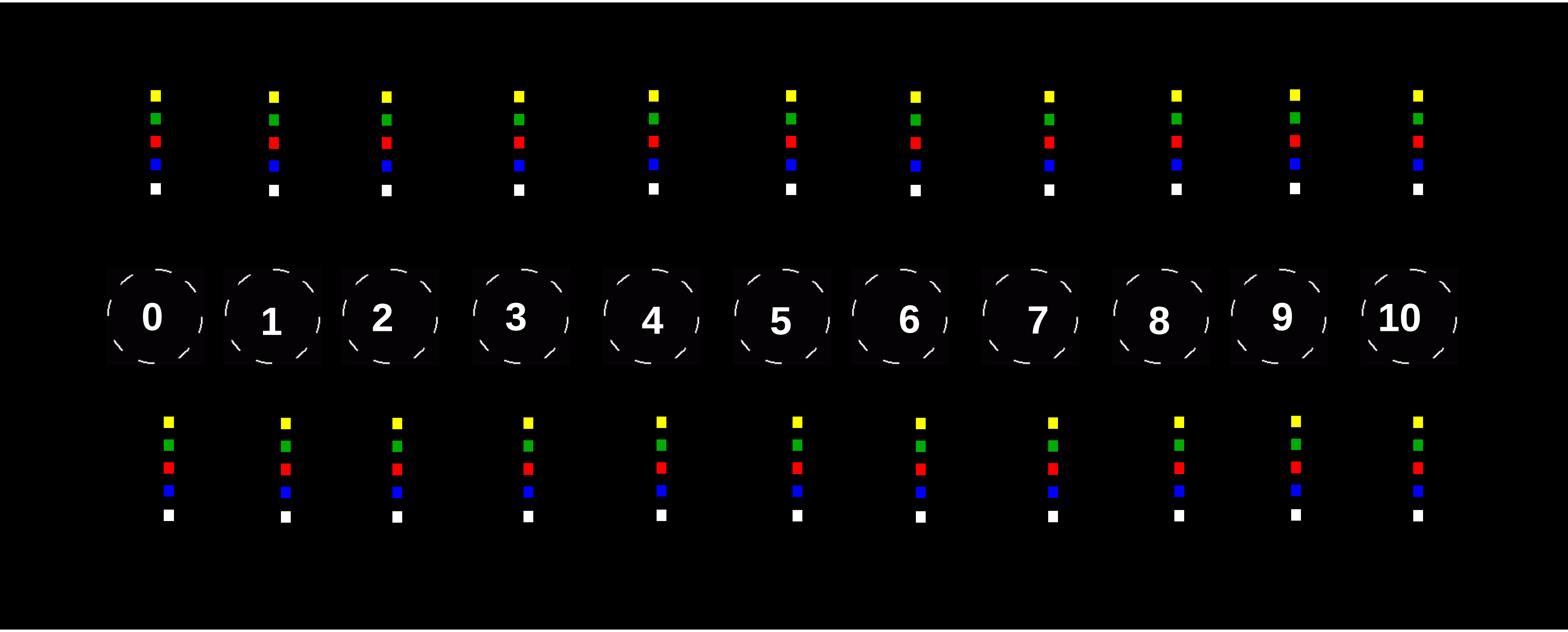


“Rotating Segmented Circles”

Allan’s view - Single Vision Lenses

All of the circles appear to be IN focus.

Each number represents 2 arc degrees when viewed at 28 inches on a 19” monitor.

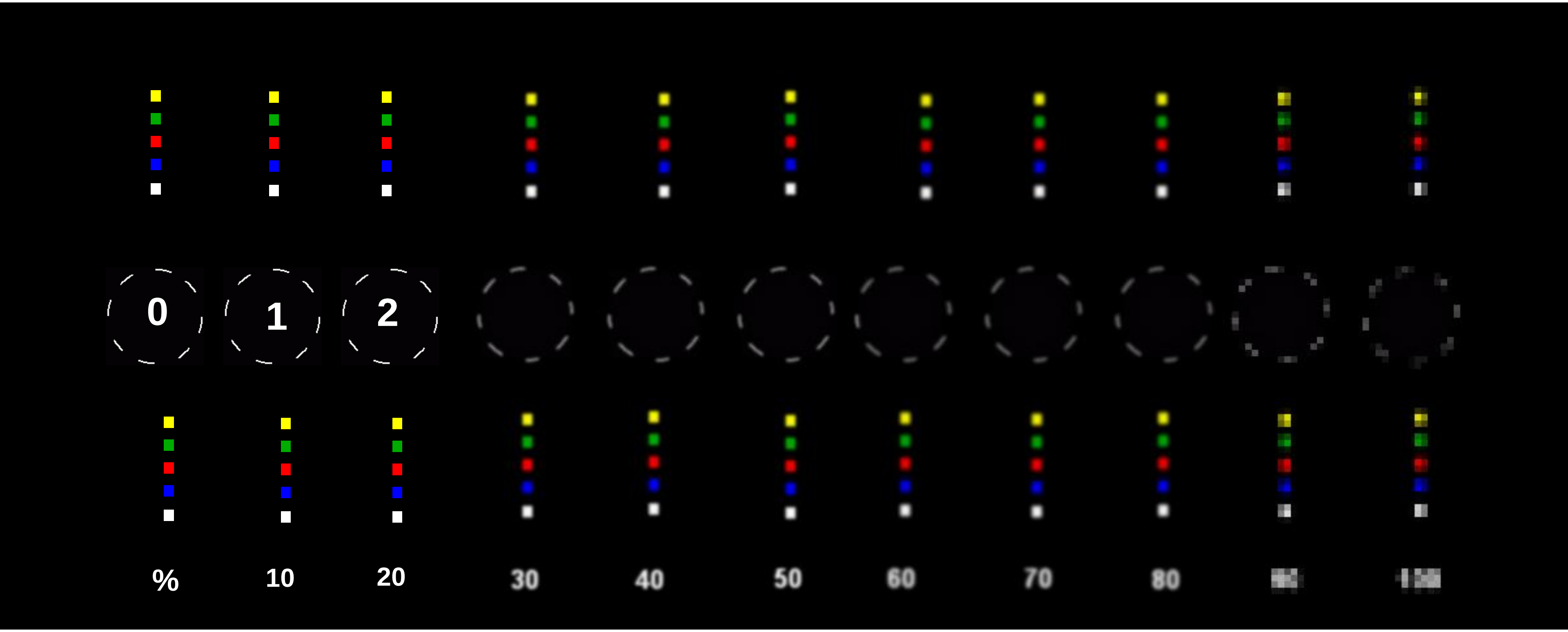


"Rotating Segmented Circles"

Allan's view - Progressive Vision Lenses

Only the primary vision area circles appear to be IN focus.

Each number represents 2 arc degrees when viewed at 28 inches on a 19" monitor.

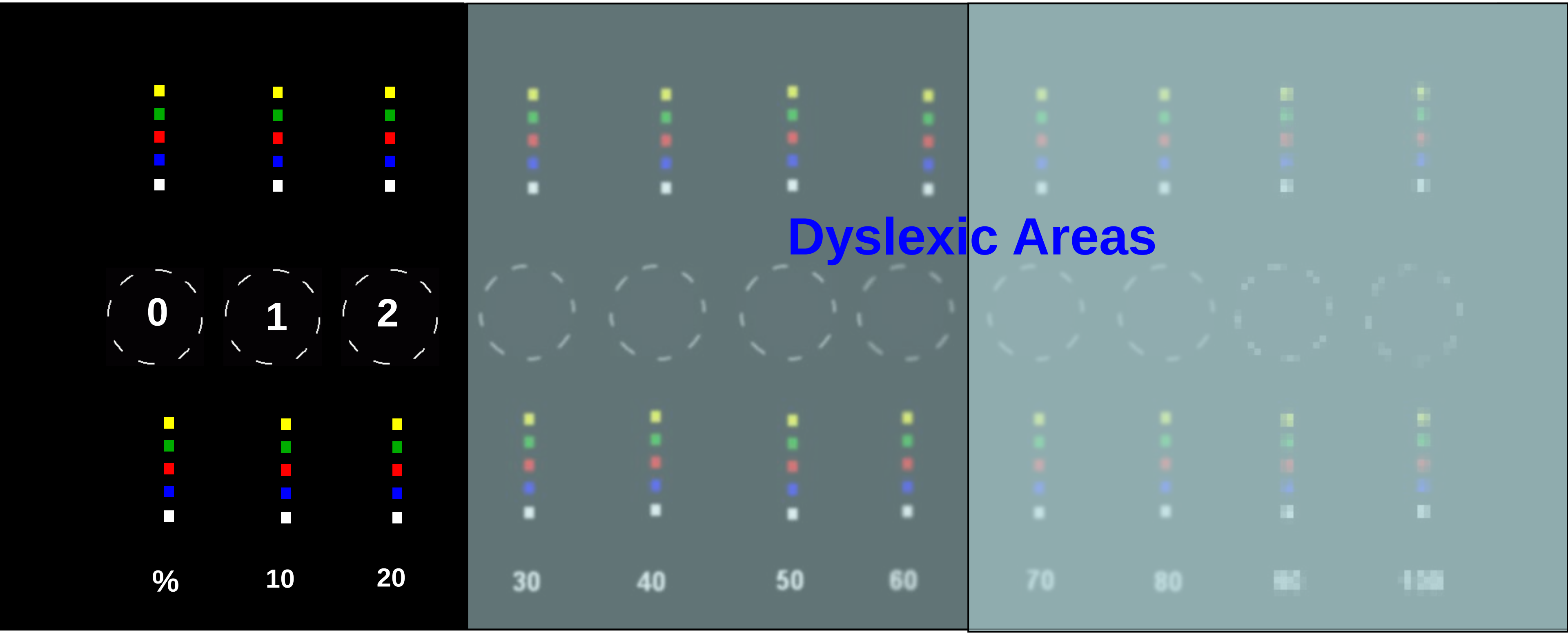


“Rotating Segmented Circles”

Allan’s view - Single Vision Lenses

As you MOVE ONLY YOUR EYE(S) the dyslexic areas become blurry with color distortion

How big should the “Rotating Segmented Circles” be?

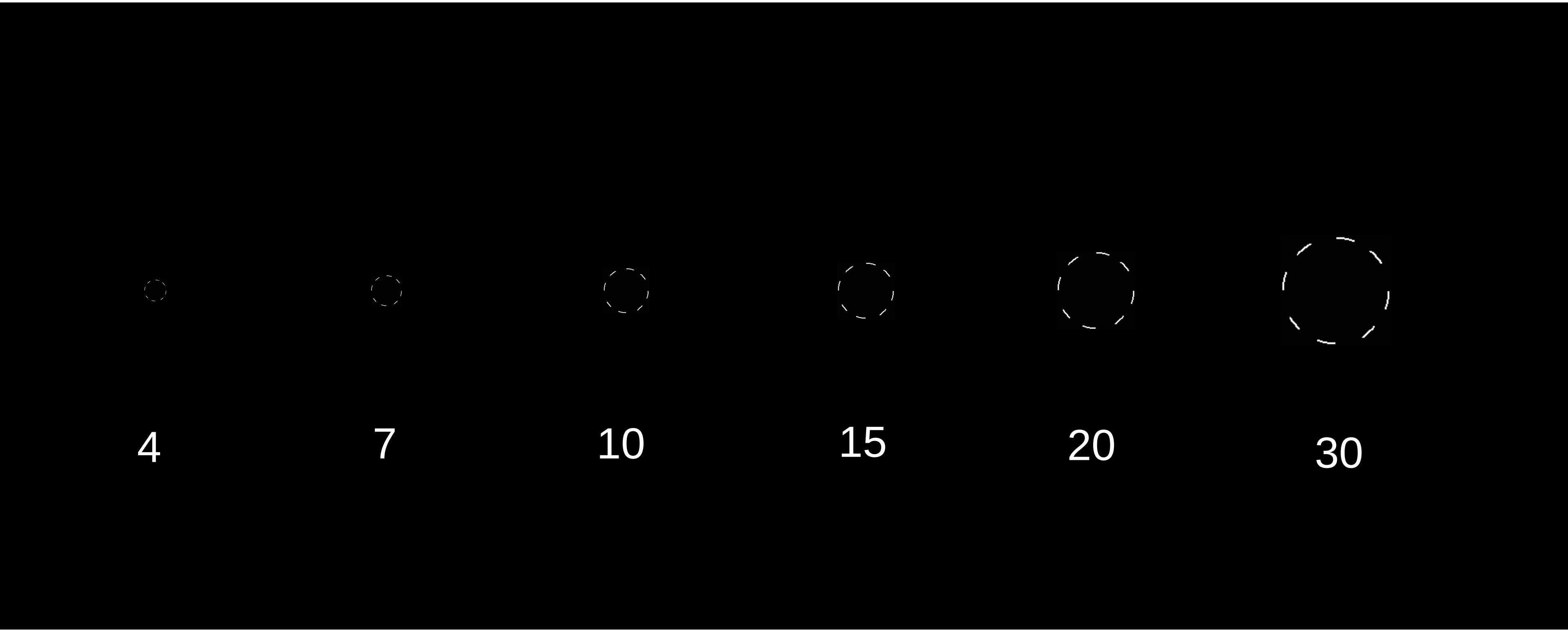


“Rotating Segmented Circles”

“How big should the circles be?”

Rotation detection of the larger images as the distance gets greater.

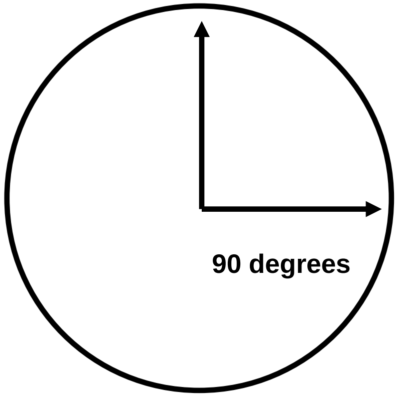
You either see the rotation or you don’t.



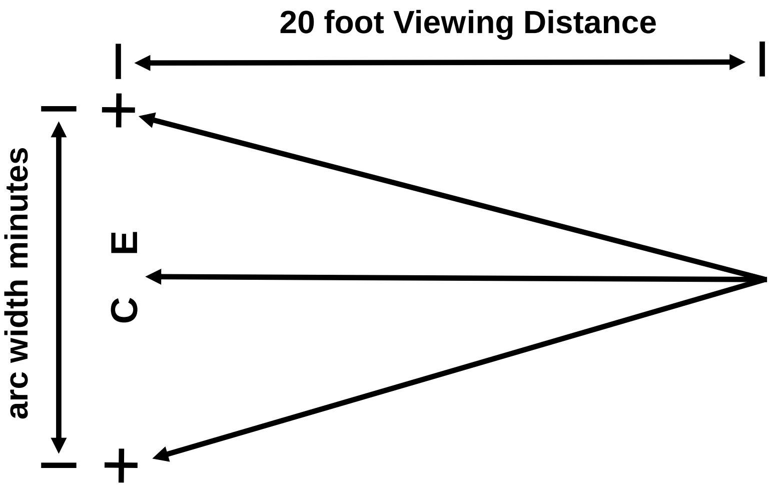
“Rotating Segmented Circles”

Welcome to Vision Science

The Dyop® concept is actually ONLY (geekie) high school math and science



Circle



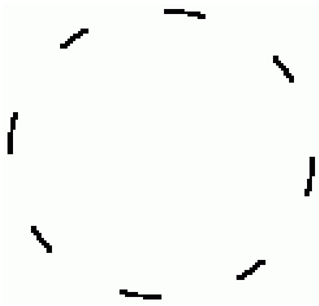
Circle = 360 degrees = 21,600 arc minutes
1 degree = 60 arc minutes
Static images = 5 arc minutes
Static diameters = 8.89 mm at 20 feet (6 m)
Dyop® images = 7.6 arc minutes
Dyop® diameter = 13.5 mm at 20 feet (6 m)

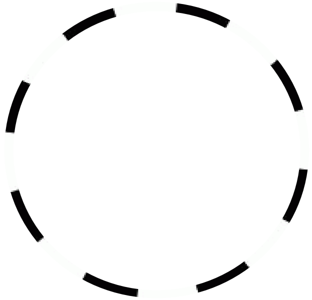
“Rotating Segmented Circles”

Dynamic Optotype = Dyop®

Variables:

Dyop® color = White vs. Black
Dyop® background = Black vs. White
Dyop® stroke width = 2.5 % stroke width to 20% stroke width?
Dyop® sectors = 2 sectors to 16 sectors?
Dyop® 20/20 diameter = 12 mm to 16 mm
Dyop® shape = dots vs. segments vs. triangles?





“Rotating Segmented Circles”

Stroke Width versus Perception Distance

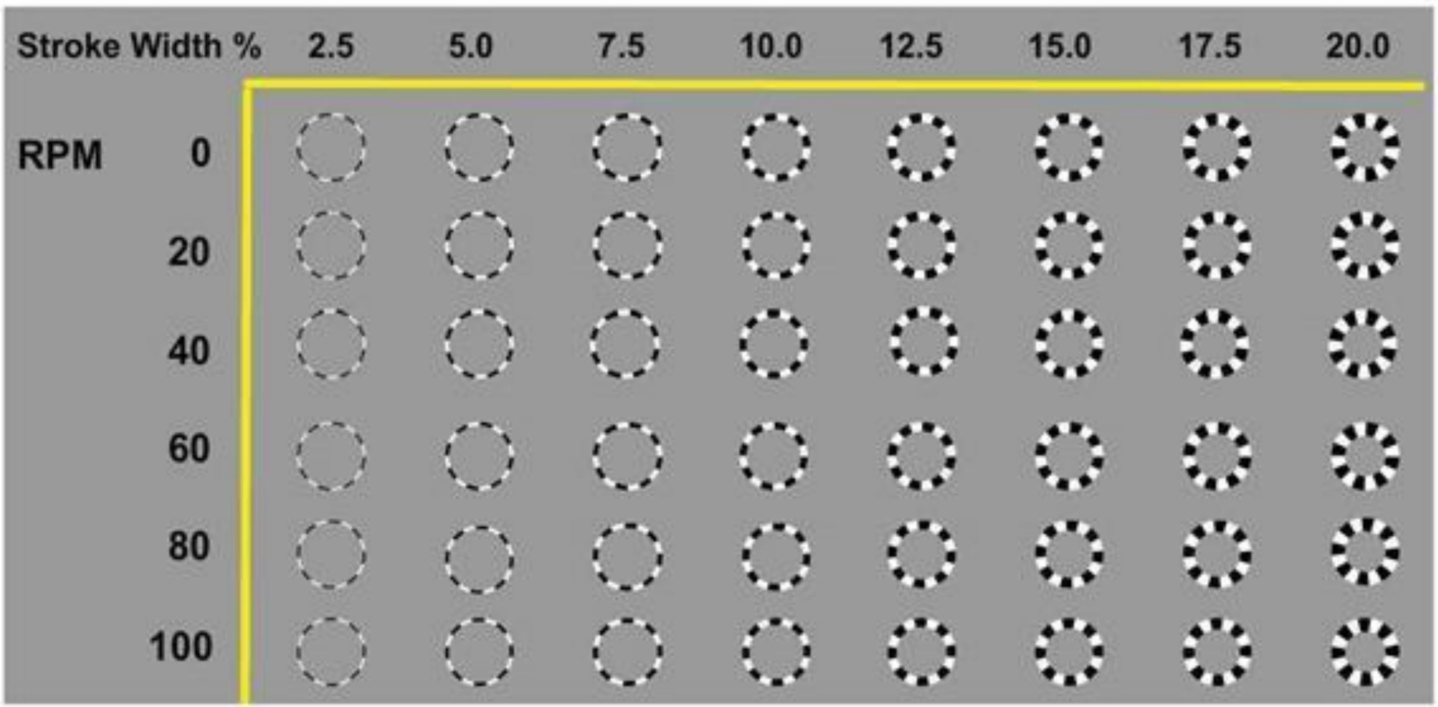
Dyop® Threshold Image versus Perception Distance as of 2009-10-27
Stroke widths (& gap widths) of 2.5%, 3.75%, and 5%
8 segments per Dyops® with 22.5 degree gap height @ 40 rpm
White segments on a Black Background

Threshold Image diameter	Perception Distance 2.5% stroke width	Perception Distance 3.75% stroke width	Perception Distance 5% stroke width
mm (* see Note)	**PD - feet***	**PD - feet***	**PD - feet***
18	24	25	26
17.25	23	24	25
16.5	22	23	24
15.75	21	22	23
15	**20**	21	22
14.25	19	**20**	21
13.5	19	19	**20**
12.9375	18	18	20
12.375	17	17	19
11.8125	16	16	18

“Rotating Segmented Circles”

Stroke Width versus Angular Arc Width

Varying the Dyop stroke width (and stimulus area) and the rotation rate indicated that the "**optimum**" Dyop had a **10% stroke width**, an angular width of **7.6 arc minutes**, and a rotation rate of **40 rpm**.



“Rotating Segmented Circles”

Stroke Width versus Angular Arc Width

Note that it is easier to detect the gap/segments of a static Dyop (zero rpm) than a Dyop at 20 rpm and 40 rpm. This disparity indicates that static image fixation increases the gap/segment visibility of static optotypes, thus increasing the tendency for an over-minused refraction.

SW % RPM	2.5%	5.0%	7.5%	10.0%	12.5%	15.0%	17.5%	20.0%
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

How We See

“Allan’s Pixel Theory of Acuity”

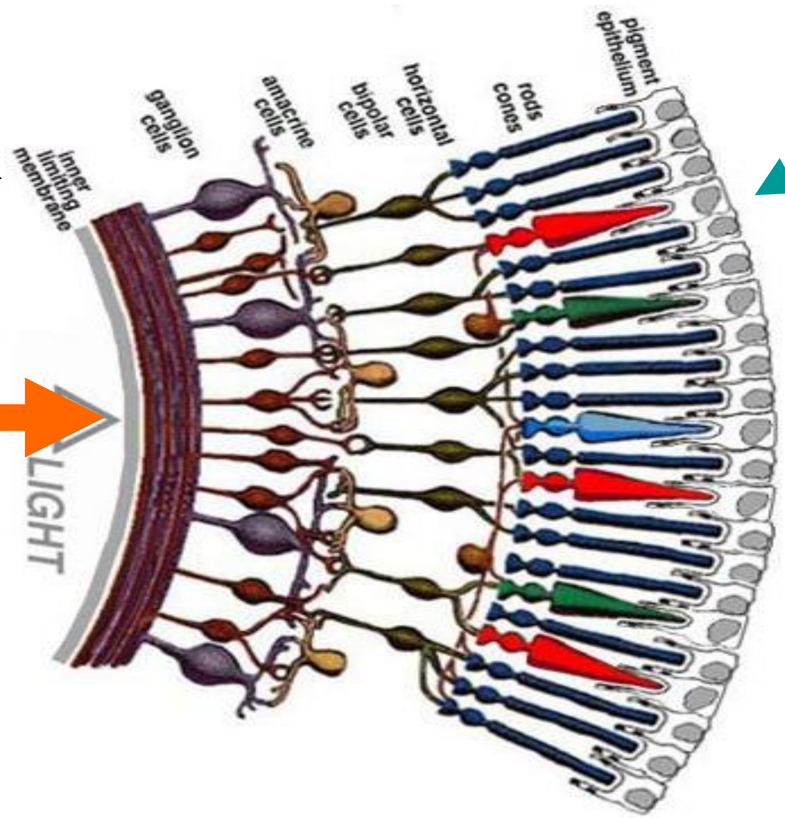
Our eyes developed to detect motion, distance, and color

Emitted (computerized) light increases perception

4 layers of Neural Cells

Epithelium

Light



Photoreceptors

100 Photoreceptors

↓

1 Optic Nerve Fiber

How We See

“Allan’s Pixel Theory of Acuity”

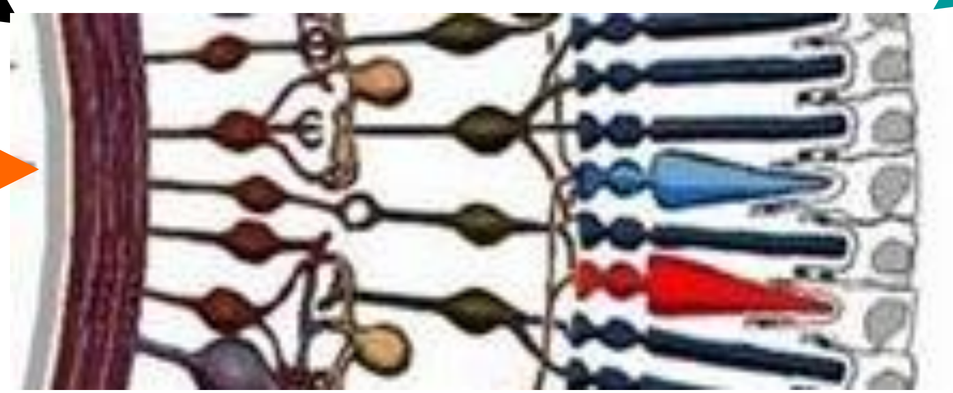
Stiles-Crawford Effect increases the perception of emitted light due to photoreceptors being at the BACK of the retina.

4 layers of Neural Cells

Epithelium

Photoreceptors

Light



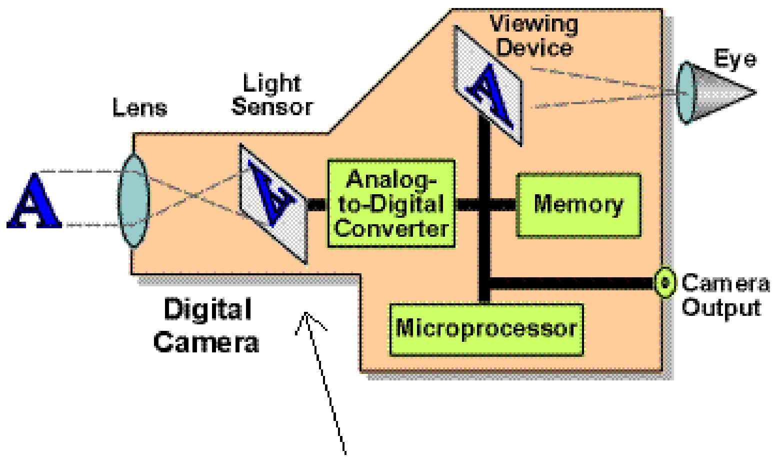
100 Photoreceptors

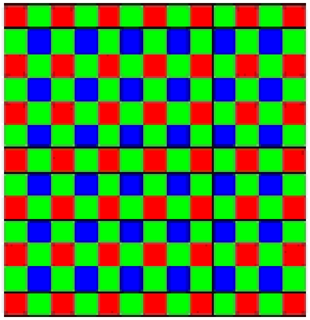
1 Optic Nerve Fiber

How We See

"Allan's Pixel Theory of Acuity"

The eye is akin to a digital camera





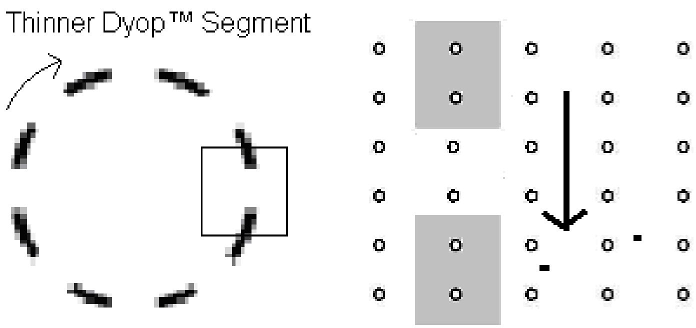
Bayer Filter - Light Senor

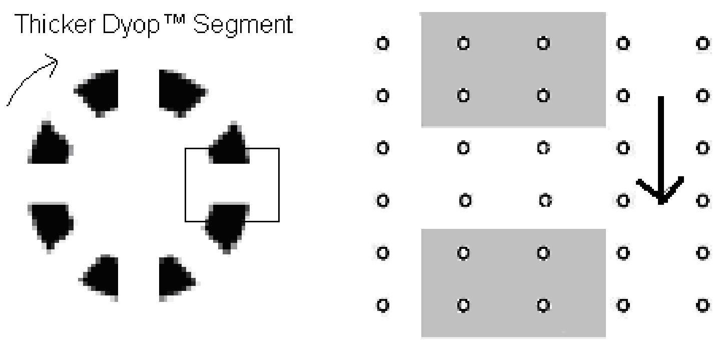
How We See

“Allan’s Pixel Theory of Acuity”

The eye is akin to a digital camera

Dyop® stroke width versus photoreceptor stimulus path





Thinner Dyop® = thinner segment photoreceptor stimulus

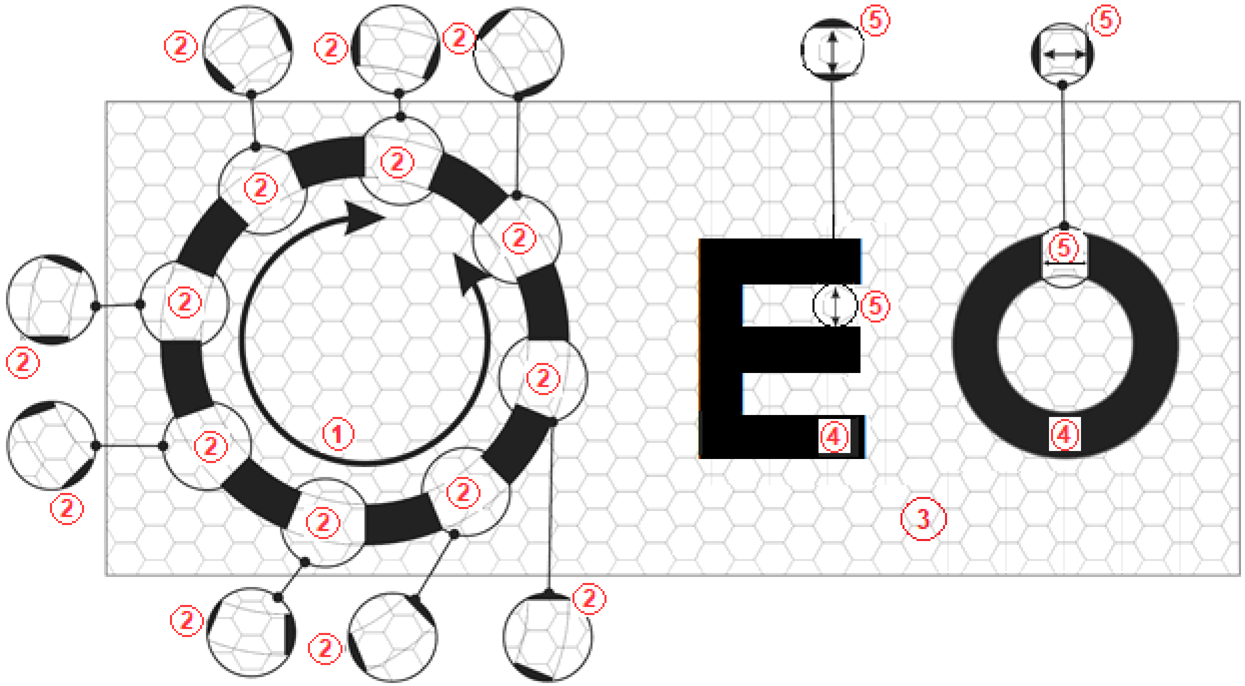
Thicker Dyop® = thicker segment photoreceptor stimulus

20/20 Snellen = 6/6 metric = 7.6 arc minutes angular width = 0.76 arc minute gap/segment width or 0.54 arc minutes squared or about 20 photoreceptors

How We See

"Allan's Pixel Theory of Acuity"

Dyop® strobic stimulus of the photoreceptors



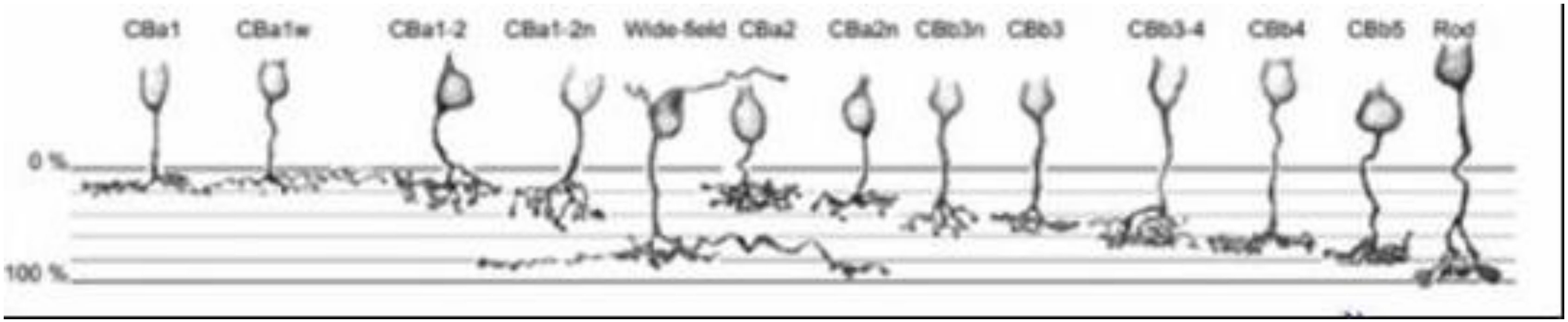
Item 1 – visual angular velocity or strobic contrast response
Item 2 – a moving segment visual arc-area dynamically stimulating retina cells with motion
Item 3 – retinal cells
Item 4 – an example of a static historical optotype
Item 5 – a static minimum angle of resolution of a historical optotype

How We See

“Allan’s Pixel Theory of Acuity”

The eye is akin to a biological computer

Types of unique neurons in the retina

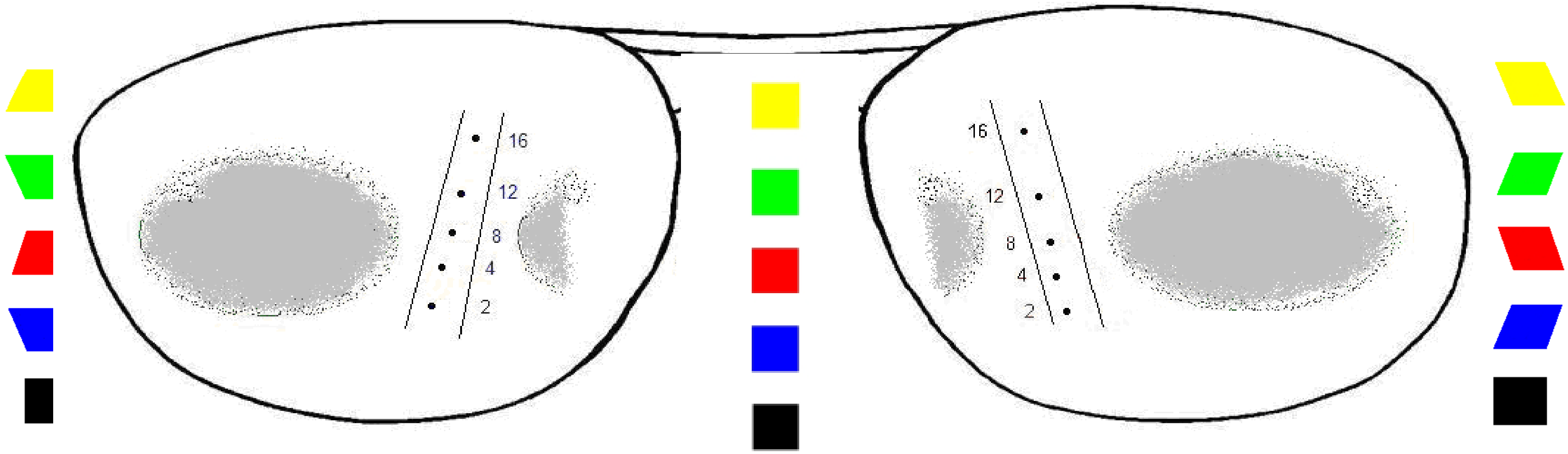


Dyop® strobic stimulus of the photoreceptors detects motion and color

How We See In Color

Allan's view - Progressive Lenses

Peripheral color distortion reduces comprehension



Left ← **Normal colors** **→ Right**

Dyslexic Area

Astigmatic color shift

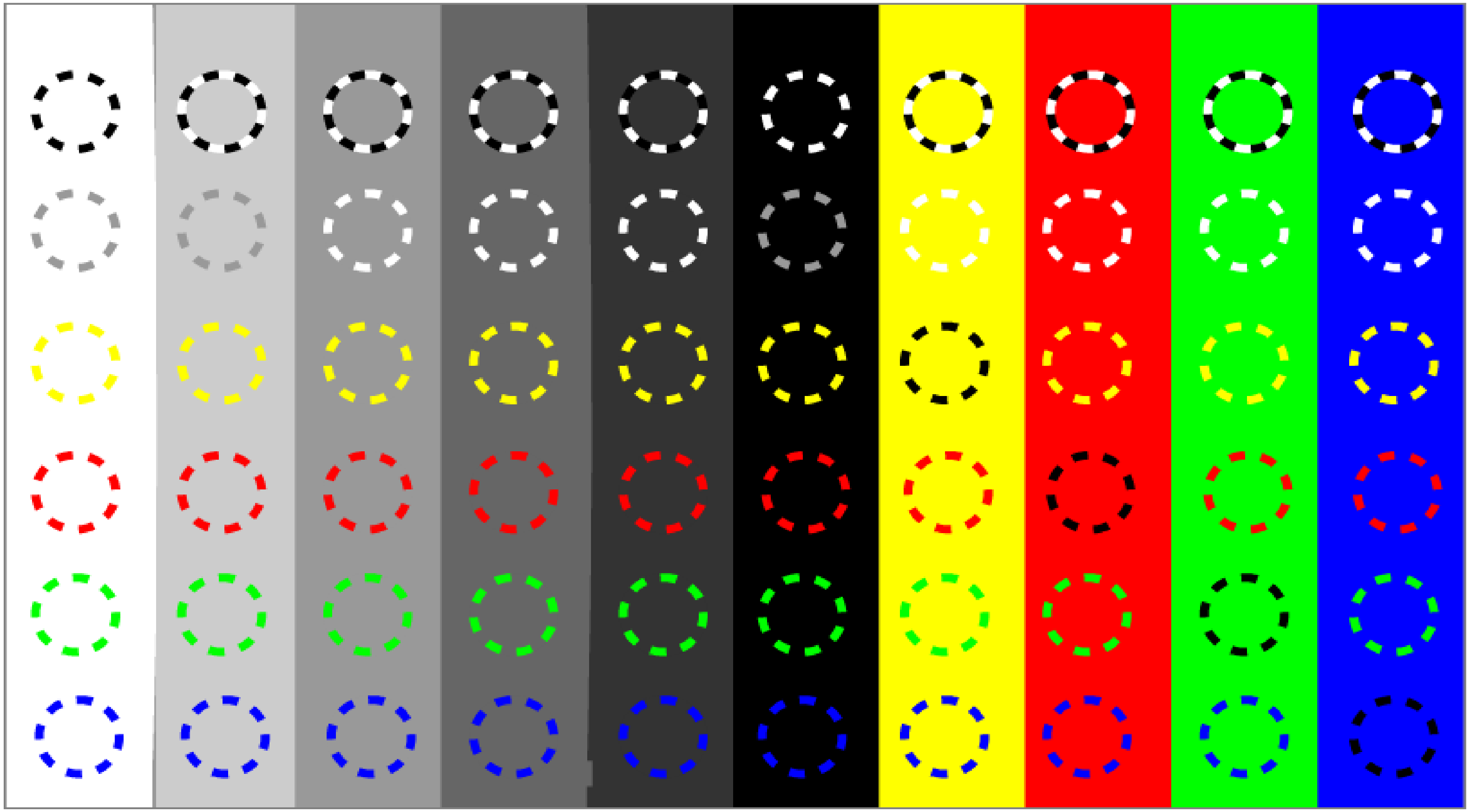
Dyslexic Area

Astigmatic color shift

How We See In Color

If we see in color…

what colors do we see?



60 acuity endpoint color/contrast combinations.

How We See In Color

If we see in color…

what colors do we see?

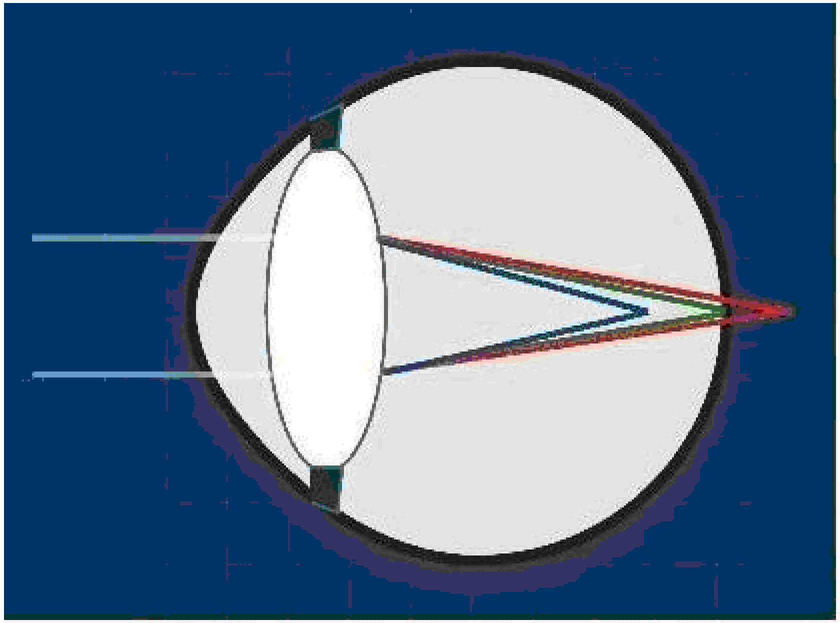
	White/G1	Gray2	Gray3	Gray4	Gray5	Black/G6	Amber	Red	Green	Blue
G1/G1	g6_g1	g6g1_g2	g6g1_g3	g6g1_g4	g6_g5	g1_g6	g1g6 _amber	g1g6 _red	g1g6 _green	g1g6 _blue
Rotation Detection Distance	23	22	20	21	21	22	25	23	24	21
G3/G1	g3_g1	g3_g2	g1_g3	g1_g4	g1_g5	g3_g6	g1_amber	g1_red	g1_green	g1_blue
Rotation Detection Distance	26	30	23	23	25	24	38	24	27	22
Amber	amber_g1	amber_g2	amber_g3	amber_g4	amber_g5	amber_g6	g6_amber	g6_red	amber _green	amber _blue
Rotation Detection Distance	40	32	24	23	22	23	22	23	30	23
Red	red_g1	red_g2	red_g3	red_g4	red_g5	red_g6	red_amber	g6_red	red_green	red_blue
Rotation Detection Distance	25	28	34	27	25	24	24	27	23	29
Green	green_g1	green_g2	green_g3	green_g4	green_g5	green_g6	Green _amber	green _red	g6 _green	green _blue
Rotation Detection Distance	28	40	28	23	22	22	32	23	23	24
Blue	blue_g1	blue_g2	blue_g3	blue_g4	blue_g5	blue_g6	blue _amber	blue _red	blue _green	g6 _blue
Rotation Detection Distance	25	28	34	34	27	25	24	30	23	27

60 color acuity endpoints with the endpoint distances in feet.

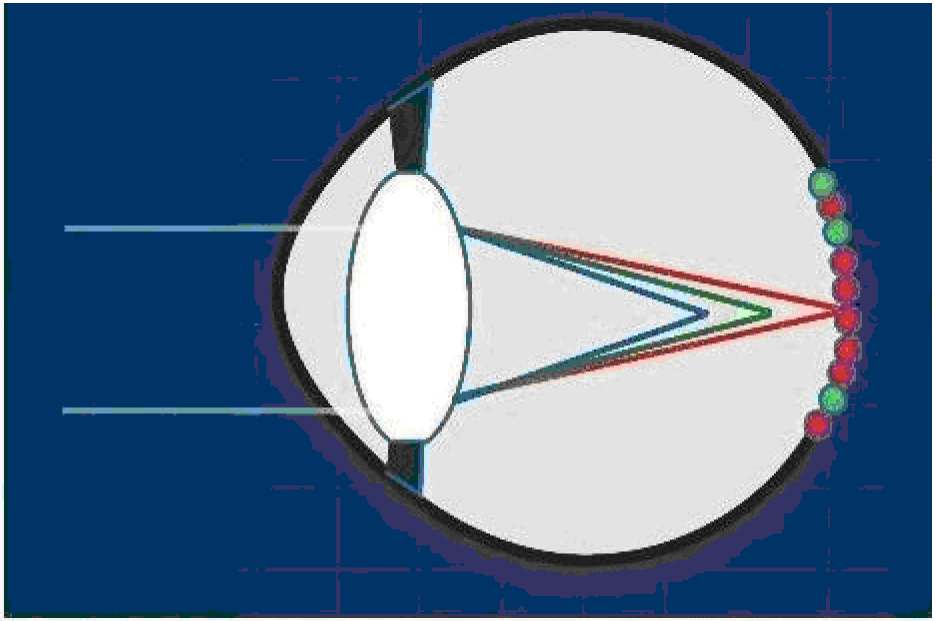
The optimum (minimum) combination is Black/White-on-Gray.

How We See In Color

The colors of Blue, Green, and Red are bent by the lens.
Green is focused on the retina for more stable near vision.
Red is focused on the retina for a more stable distance image.



Green Focused Vision (GFV)
50% Red and 45% Green photoreceptors



Red Focused Vision (RFV)
75% Red and 20% Green photoreceptors

How We See In Color

"Green Focused Vision" has **50% Red**, **45% Green**, and **5% Blue** photoreceptors.

"Red Focused Vision" has **75% Red**, **20% Green**, and **5% Blue** photoreceptors **("slow readers" or dyslexics).**

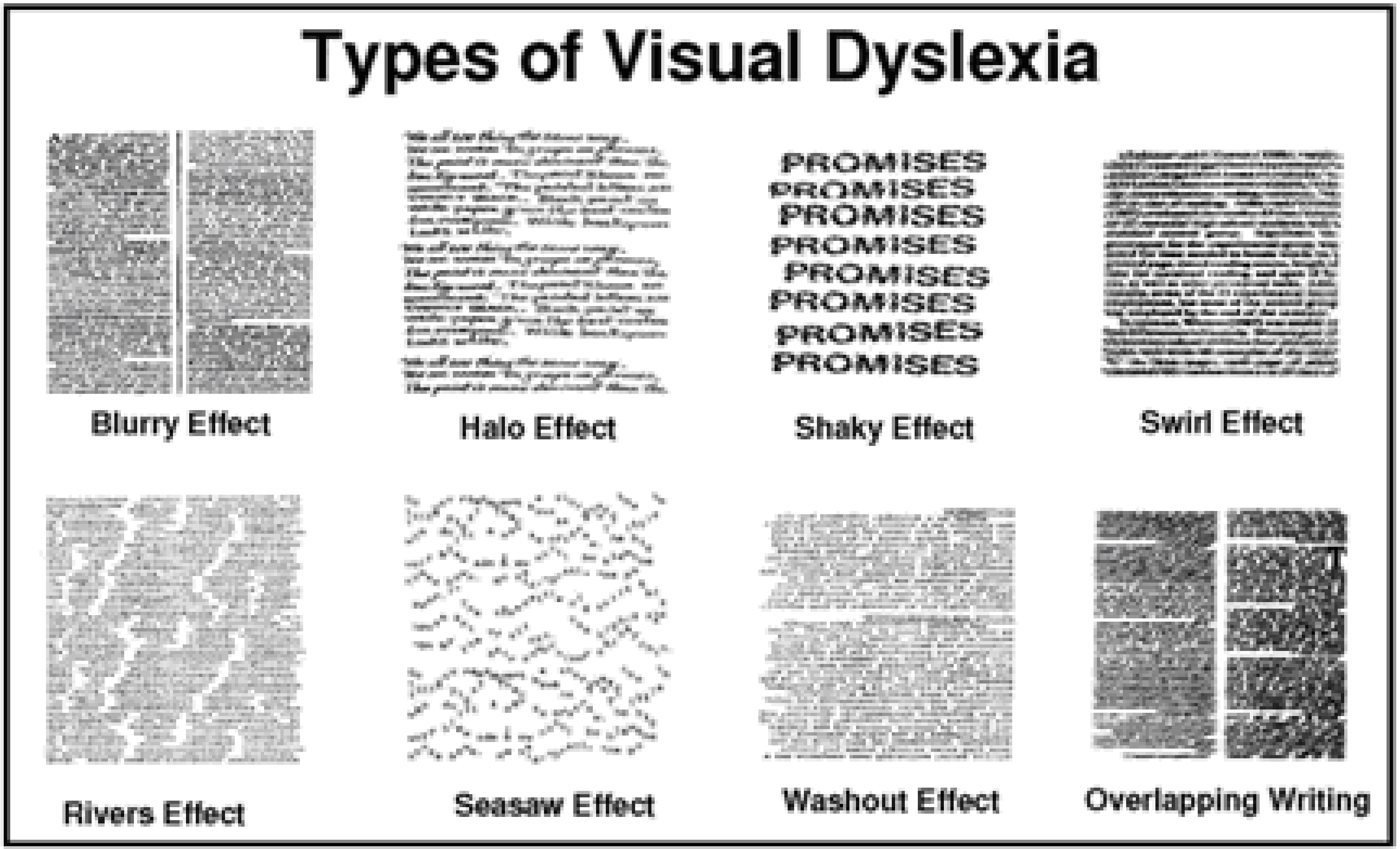
Rough estimate of photoreceptor distribution*:

Vision Type	% Red (L)	% Green (M)	% Blue (S)
Green-Focused	50	45	5
Red-Focused	75	20	5

*** Dr. Chris Chase, Western University, Pomona, CA**

Dyop® Color/Dyslexia Screening

Visual stress is from an unstable near image.

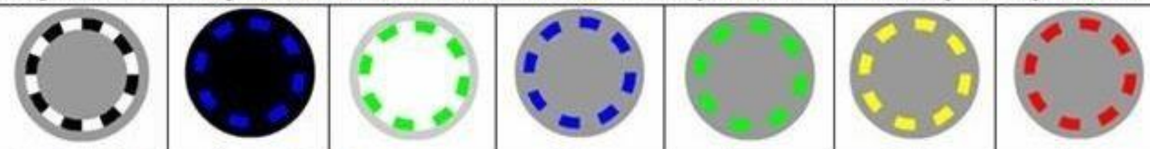


How We See In Color

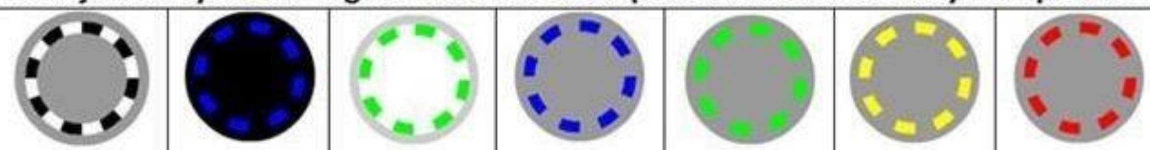
The ratio of Red, Green, and Blue photoreceptors is directly related to their color acuity endpoints.

Note: smaller arc width indicates better acuity

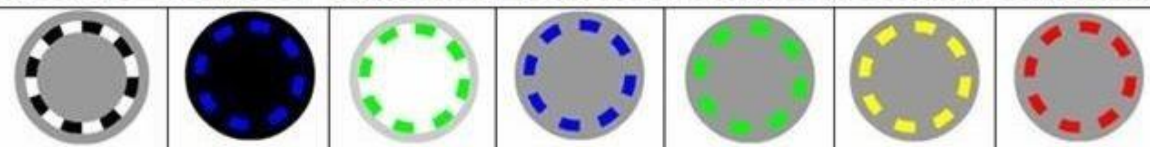
Myope - 6 Subjects - Non-dyslexic - Balanced Red Photoreceptors Color Acuity Comparison

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

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	20/20	20/30	20/65	20/75	20/50	20/40	20/60

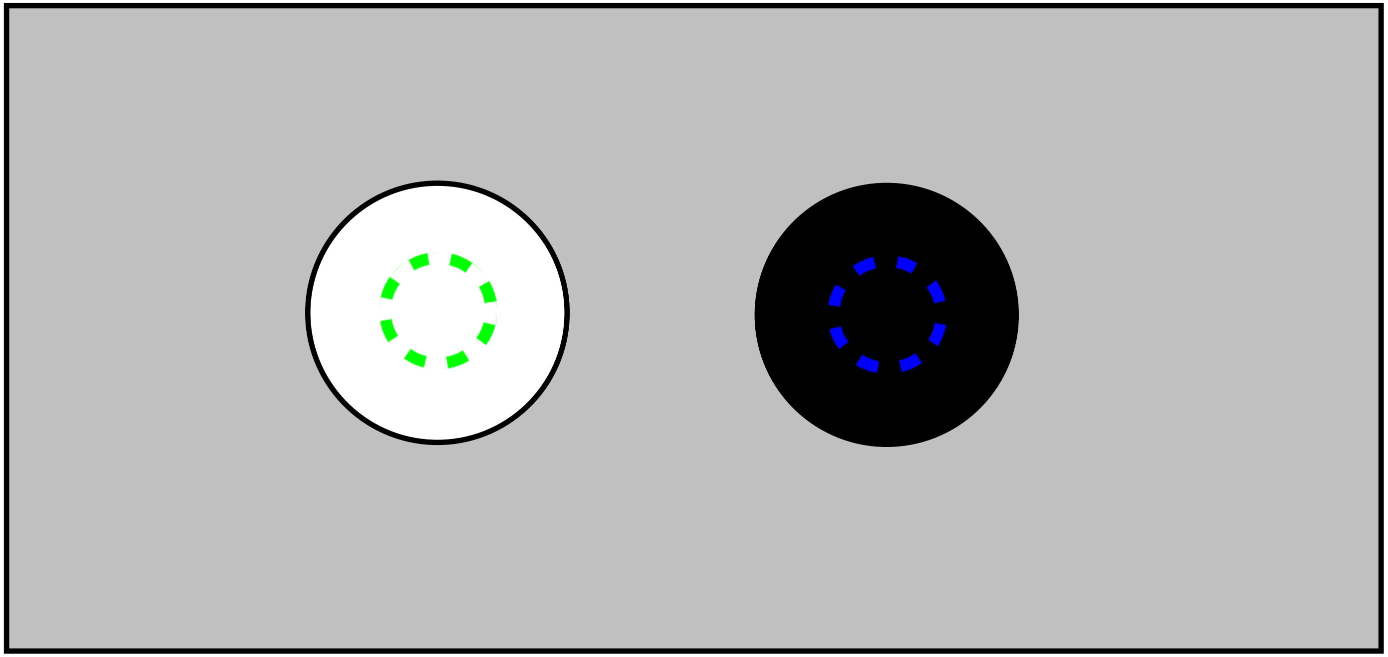
Color-Blind Hyperope - 3 Subjects - Higher Red Photoreceptor Ratio Color Acuity Comparison

Dyop							
Color	Basic Acuity	Chromatic	Screening	Blue	Green	Amber	Red
Arc Width	8	14	12	10	22	14	10
Snellen	20/20	20/60	20/45	20/30	20/130	20/60	20/30

Dyop® Color/Dyslexia Screening

Which color/contrast can you see most clearly?
Color preference directly related to visual stress.

Green-on-White or Blue-on-Black

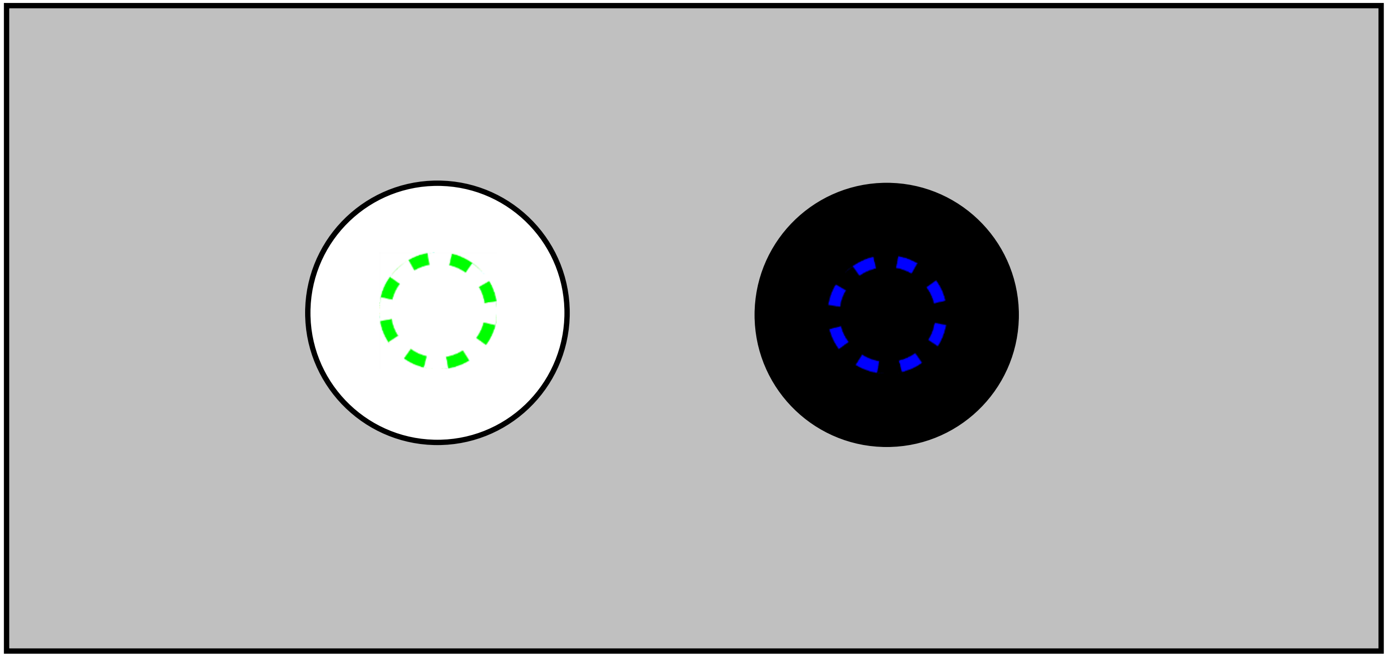


Dyop® Color/Dyslexia Screening

“**Green-Focused Vision**” sees rotation of a **Green** Dyop® on a White background better than a **Blue** Dyop® on a Black background.

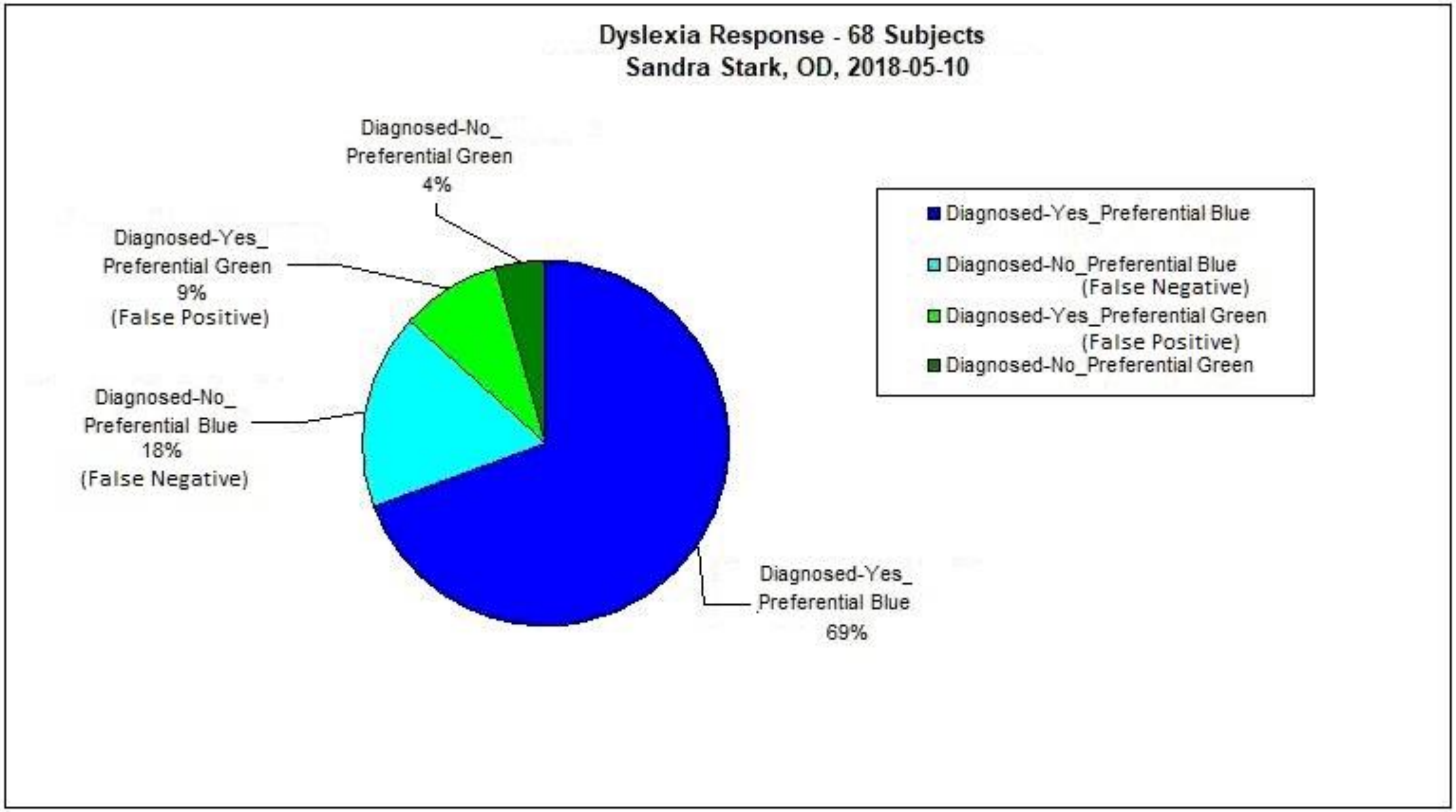
“**Red-Focused Vision**” sees rotation of a **Blue** Dyop® on a Black background better than a **Green** Dyop® on a White background.

Green-on-White   or   Blue-on-Black

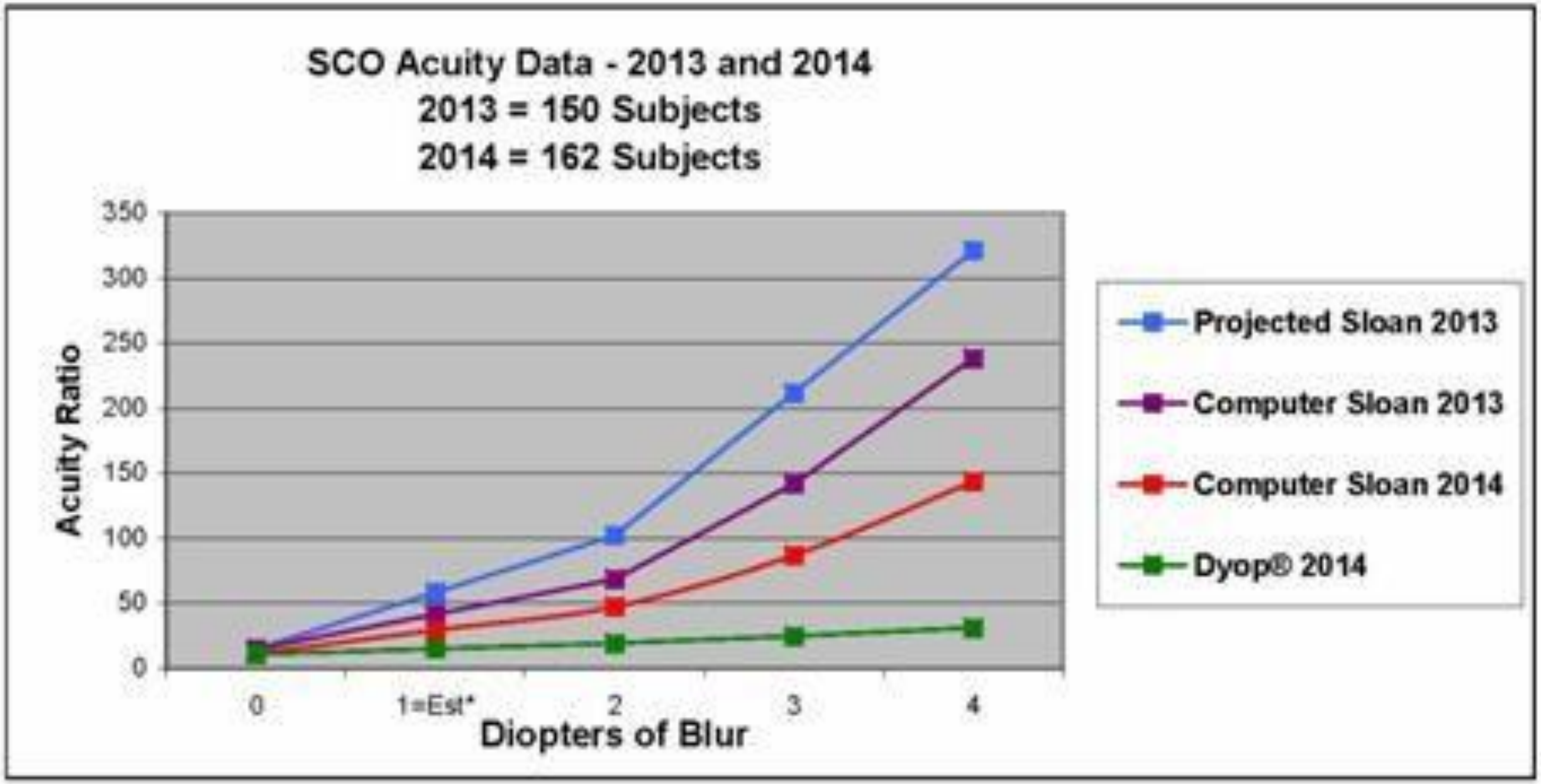


Dyop® Color/Dyslexia Screening

Preliminary Research
“Only” 73% correlation to diagnosed symptoms of dyslexia



Dyop® Vision Standards



Acuity Study – Dr. Paul Harris, SCO

Increased Dyop® precision and reduced over-minus

Dyop® Vision Standards

Reduced Dyop® Variance

Study Condition	Variance
Projected Sloan (2013)	0.282
Sloan letters (2013)	0.233
Sloan letters - Harris Method (2014)	0.193
Dyop - Doublet (2014)	0.035

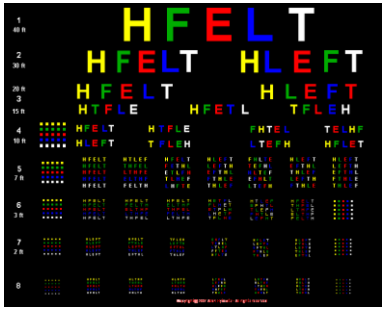
Table 1 summarizes the variance in the test conditions over the two years of the study.

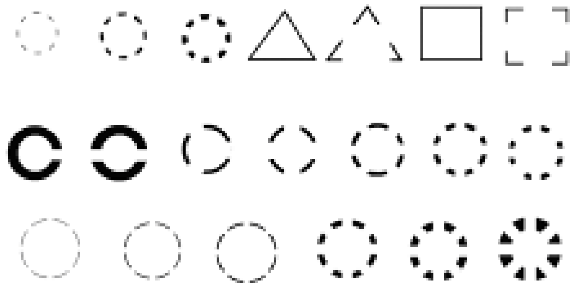
Acuity Study - Dr. Paul Harris, SCO

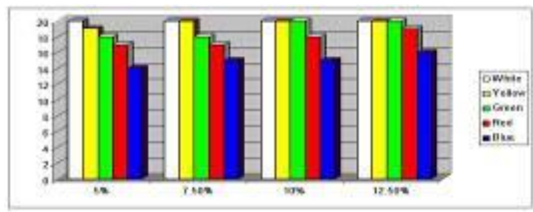
Dyop® Vision Standards

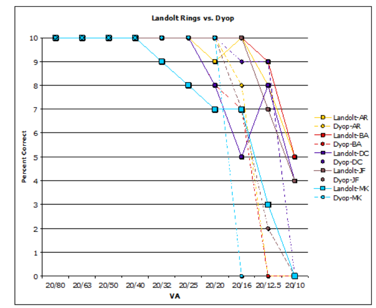
- Eliminates cultural and educational testing bias
- Resolution acuity rather than cultural recognition acuity
- Standards based upon physiology rather than comprehension
- Increased precision (up to 6x Research mode – 3X Clinical)
- Faster administration (up to 3x)
- Improves low vision testing
- Infant / non-literate testing relevant to adults
- Precise color perception testing
- Simple software configuration
- Does NOT need FDA approval

12,000 Hours Later…









The Dyop® Revolution

US008083353B2

(12) **United States Patent**
Hytowitz

(10) **Patent No.:** **US 8,083,353 B2**
(45) **Date of Patent:** **Dec. 27, 2011**

(54) **ANIMATED IMAGE VISION TEST**

(76) Inventor: **Allan N Hytowitz**, Alpharetta, GA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Aug. 17, 2009**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
A61B 3/02 (2006.01)

(52) **U.S. Cl.** **351/239**

(58) **Field of Classification Search** 351/239
See application file for complete search history.

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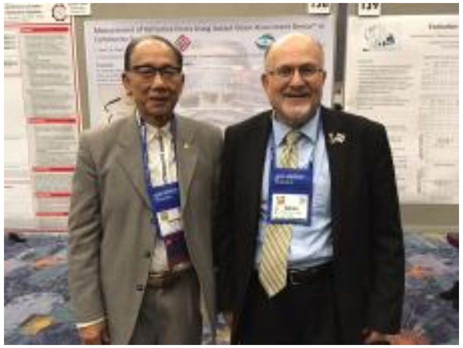
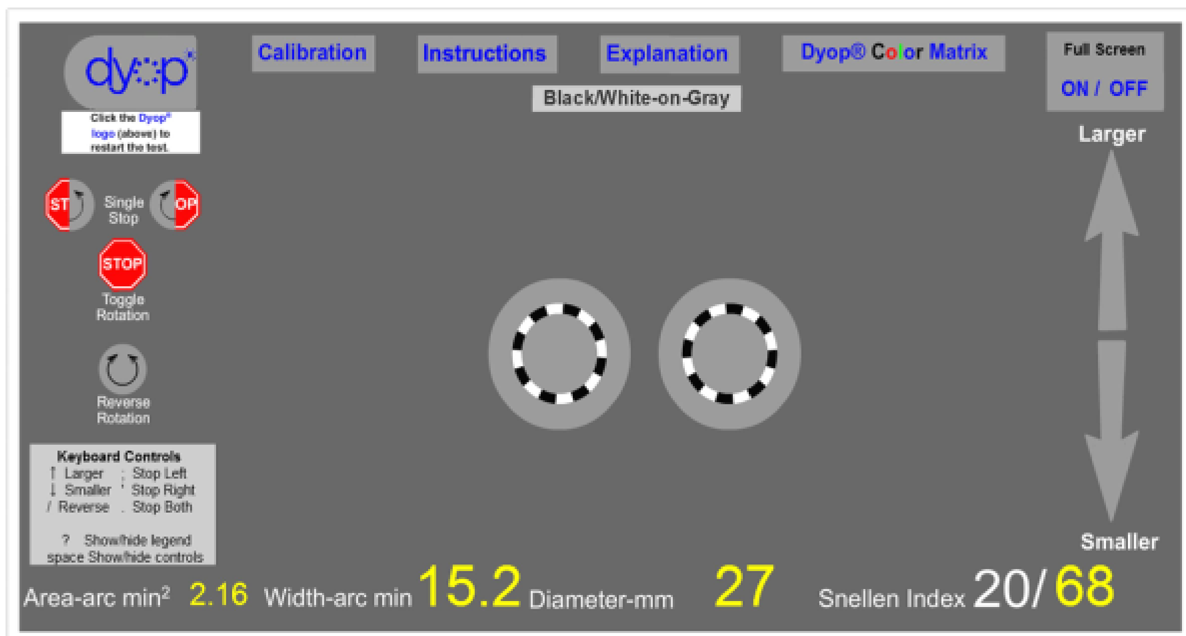
(57) **ABSTRACT**

Animated image vision tests take advantage of the ability of our eyes to detect both distance and motion. Moving images, such as rotating segmented circles, let the eyes detect motion as to the size, distance, and rotation direction of that moving image. That motion detection is much more precise than the interpretation of multiple static letters or static images. Using rotating images for vision testing rather than static images creates an acuity test more accurate than current tests, a test that is faster to use, and a test that doesn't require the ability to read.

1 Claim, 17 Drawing Sheets

18,000 Hours Later…





The Dyop® Revolution

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UNDERSTANDING THE Dyop® TEST

A Dyop is a revolutionary 21st century way of measuring vision.

Twenty-first century electronic images use pixels which change color and intensity to create the images we see. The photoreceptors of the eye function much like those pixels. Your brain uses the photoreceptor response to create vision and bring that image into focus. When the moving gaps and segments of a Dyop (short for dynamic optotype) get too small, their strobic stimulus is too small for the pixel effect to be detected by the photoreceptors of the eye. The smallest Dyop gaps and segments detected as moving create an acuity and refraction endpoint.

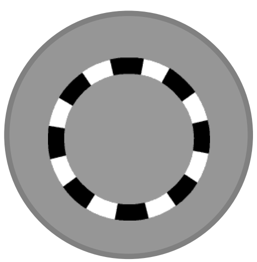
Faster and more accurate acuity and refractions.

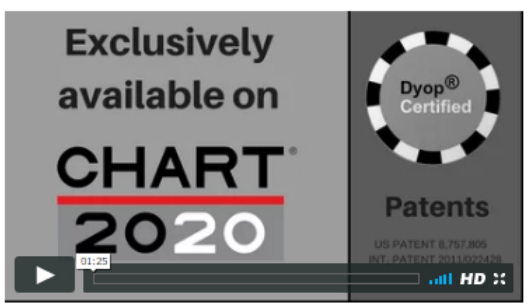
Unlike static image vision tests, such as a logMAR or Snellen chart which get increasingly blurry as they get smaller, the rotation of the Dyop appears to stop when the acuity threshold is reached. A Dyop is a segmented, circular figure composed of equally spaced segments that rotates at constant velocity. A patient is presented with 2 Dyops, side by side, one moving and one static and is asked to determine the direction of the spinning Dyop.

What is detected is not so much the motion of the gaps and segments, but that strobic stimulus on the photoreceptors in the eye.

As the angular width of the Dyop diameter and the gap/segments gets sufficiently smaller, the strobic stimulus is no longer sufficiently large enough for the motion of the gap/segments to be detected.

The added precision and reliance upon a visual physiological response, rather than cognition of European-type letters, provides a more precise, consistent, accurate, and efficient method for measuring visual acuity. It also lets the Dyop test be used for people with limited literacy and vision for method visual acuity. It also lets the Dyop test be used for people with limited literacy and vision for children.





Welcome to the Dyop® Revolution

"The benefit of technology is NOT in what it lets people accomplish but in how it improves the character of people."

- Allan Hytowitz

"In every revolution, there is one man with a vision."

- James Kirk

U.S. Patent 8,083,353 and Published International Patent US2010/045798 already approved