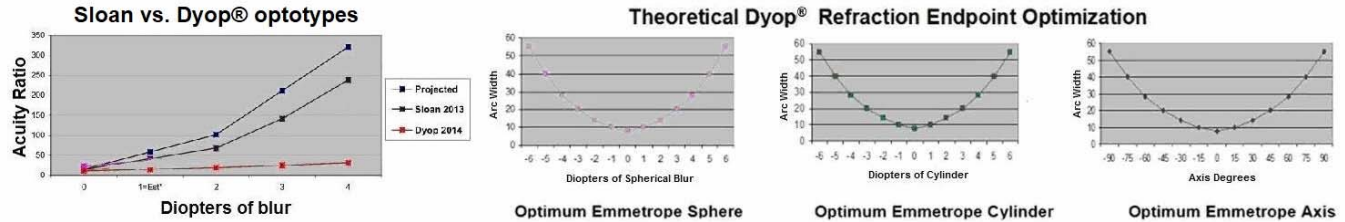


Dyop® Refraction Procedure

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A Dyop® is a rotating/spinning segmented optotype ring whose contrasting gap/segment motion provides a strobic stimulus of the photoreceptors used to determine visual acuity and refractions. The Dyop® **Visual Acuity Endpoint** is the smallest segmented ring diameter where the Dyop® is clearly detected as spinning. A Dyop® whose gap/segments only “twinkle” rather than definitively spin is **NOT “spinning.”**

The smaller visual stimulus area of a Dyop® (0.54 arc min squared), versus the Snellen/Sloan/Landolt optotypes (1.0 arc min squared), results in the Dyop® angular arc width diameter having an almost linear relationship to diopters of blur versus the typical logarithmic Snellen increase. That linear relationship is for both for myopia (minus sphere) and hyperopia (plus sphere). That minimum Dyop® arc width where spinning/rotation is detected also creates an “optimum” value for sphere, cylinder, and axis, and is the Minimum AREA of Resolution (**MAR**).



The linear increase in the Dyop® arc width with blur creates a more precise indicator of acuity than Snellen or Metric measurements. The initial **Dyop® Unaided Acuity (DUA)** is smallest **unaided** Dyop® arc width diameter in arc minutes (**am**) where spinning can be detected. That **Dyop® (DUA)** value determines an **Emmetrope Comparison Value (ECV)** in arc minutes and an **Initial Refraction Sphere (IRS)** in diopters. An 8 **DUA arc minute** value will be an emmetrope equivalent to Snellen 20/20 or Metric 6/6. Because of the Dyop® **arc minute** value has a linear increase with blur, subtract 8 from the **DUA arc minute** to find the **ECV arc minute equivalent**. That **ECV arc minute** value is divided by 6 to get the initial +/- **IRS** diopter setting, which will be plus (+) for a hyperope and minus (-) for a myope. An incorrect plus (+) or minus (-) **IRS** lens setting will make the spinning Dyop blurrier. For example, a **DUA** of 14 **am** corresponds to either a plus (+) or minus (-) **one** diopter of sphere (**DUA** of 14 **am** minus 8 = **ECV** of 6 **am**; 6/6 = **IRS** 1 diopter). A **DUA** of 20 **am** will be to **two** diopters (**DUA** of 20 **am** minus 8 = **ECV** of 12 **am**; 12/6 = **IRS** 2 diopters), a **DUA** of 26 **am** will be **three** diopters (**DUA** 26 **am** minus 8 = **ECV** of 18 **am**; 18/6 = **IRS** 3 diopters), and a **DUA** of 32 **am** will be **four** diopters (**DUA** 32 **am** minus 8 = **ECV** of 24 **am**; 24/6 = **IRS** 4 diopters). **Reducing the Dyop® diameter to where spinning is NOT detected is equivalent to adding blur to a Snellen test to reduce the acuity line response.**

Snellen/Sloan	6	10	15	18	20	25	30	40	45	50	60	65	70	75	80	90	100
Metric	2	4	4.5	5.5	6	7.5	10	12	14	15	18	20	21	23	25	27	30
Dyop Unaided arc min = DUA	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Emmetrope arc min = ECV (-8.0)	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
Initial Sphere (+/-) = IRS - ROUNDED	-0.75	-0.5	-0.25	-0.25	0	0.25	0.5	0.5	0.75	1	1	1.25	1.25	1.5	1.625	1.75	2

Snellen/Sloan	110	130	150	170	200	220	250	300	350	400	475	550	650	800	1000	1300	2000
Metric	34	40	45	50	60	67	75	90	100	120	145	170	200	240	300	400	600
Dyop Unaided arc min = DUA	21	22	24	25	28	30	32	35	39	41	47	52	57	61	70	73	90
Emmetrope arc min = ECV (-8.0)	13	14	16	17	20	22	24	27	31	33	39	44	49	53	62	65	82
Initial Sphere (+/-) = IRS - ROUNDED	2.25	2.25	2.5	2.75	3.25	3.5	4	4.5	5.25	5.5	6.5	7.25	8.25	9	10.25	11.5	13.75

DUA = Dyop® Unaided Acuity **ECV = Emmetrope Comparison Value** **IRS = Initial Refraction Sphere**
DUA arc minutes minus 8 arc minutes ==> ECV arc minutes **ECV arc minutes divided by 6 ==> IRS diopters**

Before using the Dyop® test, use the Setup menu to insure proper monitor calibration and patient viewing distance. The **lower left corner** of the test screen displays the **Dyop® arc minute (am) diameter**. The **upper left corner** displays the corresponding **Sloan, logMar, Decimal, or Metric** ratio options. Use the Mouse Scroll Wheel, a Dyop® IR controller, or the Keyboard Up/Down Arrows adjusts the Dyop® diameter.

Below are the five "simple" steps to determine a refraction using a Dyop® test.

1. With **unaided acuity** determine the smallest Dyop® arc width detected as spinning (**DUA**). That **DUA arc minute** value, minus 8 arc minutes, will determine the Emmetrope Comparison Value (**ECV**). That **ECV** divided by six will determine the **Initial Refraction Sphere (IRS)**.
2. With the appropriate selected diopter (-) or (+) **IRS** lens in place, **determine the axis** by adding a - 0.50 diopter cylinder lens and rotate that cylinder lens to determine the maximum Dyop® clarity (reduced blur) as the optimum **Axis setting**.
3. With that Axis setting, **incrementally add cylinder** in 0.25 diopter increments to determine if the spinning Dyop® becomes clearer. If the Dyop® becomes blurrier, reverse the selection to remove 0.25 diopters of cylinder to find the optimum Cylinder setting.
4. **Reduce the Dyop® diameter to the smallest arc width where spinning can be detected**, then **incrementally add** either (-) 0.25 diopters (myope) or (+) 0.25 diopters (hyperope) of sphere to determine if the spinning Dyop® becomes clearer. If the spinning Dyop® becomes blurrier, reverse the selection of either (-) 0.25 diopters (myope) or (+) 0.25 diopters (hyperope) to make the spinning Dyop clearer. Use additional (+/-) 0.25 diopters cylinder increments and (+/-) 0.25 diopters sphere increments to validate the Dyop® optimum values. Reducing the Dyop® diameter will also enable avoiding the preference for an under-plused refraction with a hyperope.
5. **Continue to reduce the Dyop® diameter** to where the smallest spinning Dyop® can be detected to determine the refraction endpoint and the optimum setting for sphere, cylinder, and axis. Check for false positives by alternating the Dyop® rotation location and direction. Note that when you **overminus a myope OR overplus a hyperope** the **STATIC** Dyop will seem to get “clearer” but the **spinning Dyop® will get less clear**. You want detection of the **SPINNING** Dyop® to be as clear as possible.

Record the **Best Visual Acuity** as the **Best Dyop Aided Acuity (BDAA)** in arc minutes or the **Snellen ratio** or the **Metric ratio**. Repeat the process for each eye and binocularly. With practice, it should be possible to have the increased precision and consistency of a Dyop refraction completed in 180 seconds or less per eye.