Dyop® Refraction Procedure

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A Dyop® (short for **dy**namic **op**totype) is a segmented ring visual target using **Dynamic Visual Acuity** whose spinning gaps/segments create a **strobic stimulus** which resonates with the saccade induced refresh vibrations of the retina photoreceptors. The detection of spinning of a Dyop is much like the visual equivalent of a tuning fork to facilitate its being used for measuring acuity and refractions. The **smallest diameter (angular arc width) Dyop ring where the direction of spin is detected** is the **acuity endpoint** (with the actual clockwise or anti-clockwise direction of spin being irrelevant). **A sub-acuity Dyop** has the gap/segments blurred or "**twinkling**" rather than having a clear **spin direction.** However, unlike static Snellen optotypes, a Dyop has a linear relationship of the increase in diameter to diopters of blur but with a possible **Dyop refraction completed in 90 seconds or less per eye** with the significantly greater and consistency.

The table below illustrates the relationship of the Unaided Dyop Acuity endpoint (UDA) to diopters of blur.
UDA = initial Unaided Dyop Acuity in arc minutes minus 8 arc minutes = ECV arc minutes
ECV = Emmetrope Comparison Value in arc minutes divided by 6 = IRS in **diopters (+/-) Rounded to 0.125 diopters**
ECV arc minutes divided by 6 = IRS (Initial Refraction Setting) in diopters (+/-) Rounded to 0.125 diopters

Snellen/Sloan ratio = 20 / XX	2000	1300	1000	**800**	650	550	475	**400**	350	300	250	220	**200**	170	150	130	110	**100**
Metric ratio = 6 / XX	600	400	300	**240**	200	170	145	**120**	100	90	75	67	**60**	50	45	40	34	**30**
Unaided Dyop Acuity arc min = **UDA**	104	81	70	**62**	57	52	47	**41**	39	35	32	30	**28**	25	24	22	21	**20**
Emmetrope Comparison Value arc min = **ECV**	96	73	62	**54**	49	44	39	**33**	31	27	24	22	**20**	17	16	14	13	**12**
Initial Refraction Setting (+/-) = **IRS diopters**	16	12.125	10.375	**9**	8.125	7.375	6.375	**5.5**	5.25	4.5	4	3.5	**3.25**	3	2.5	2.25	2.25	**2**

Snellen/Sloan ratio = 20 / XX	90	80	75	70	65	**60**	50	45	40	32	25	**20**	18	15	10	6
Metric ratio = 6 / XX	27	25	23	21	20	**18**	15	14	12	9.5	7.5	**6**	5.5	4.5	4	2
Unaided Dyop Acuity arc min = **UDA**	19	18	17	16	15	**14**	13	12	11	10	9	**8**	7	6	5	4
Emmetrope Comparison Value arc min = **ECV**	11	10	9	8	7	**6**	5	4	3	2	1	**0**	-1	-2	-3	-4
Initial Refraction Setting (+/-) = **IRS diopters**	1.75	1.62	1.5	1.25	1.25	**1**	1	0.75	0.5	0.375	0. 25	**0**	-0.25	-0.375	-0.5	-0.75

Basic Dyop Refraction Steps = UDA => ECV => IRS => BDVA:

The linear Dyop ratio of increased diameter to increased spherical blur allows for a relatively simple, yet precise determination, of refractions.

1. If you **HAVE access to an autorefractor** or retinoscope, use those initial values for sphere, cylinder, and axis and **proceed to step 3.**

2. If you **DO NOT** have an autorefractor or retinoscope, determine the **Unaided Dyop Acuity** (**UDA)** as the smallest diameter Dyop angular arc width detected as spinning. Check for false positives by alternating the Dyop spin direction and/or location. Subtracting 8 arc minutes from the **UDA** determines the **Emmetrope Comparison Value** (**ECV**). That **ECV** value, when divided by six, determines the **Initial Refraction Setting (IRS) in diopters.** The correct **IRS** diopters of sphere (either + or -) **will make the Dyop appear clearer**. An **incorrect** (– or +) sphere makes the Dyop blurrier.

3. With the correct initial (– or +) **IRS** diopter spherical lens in place, **verify the axis** by adding - 0.50 diopters or more of cylinder. Rotate that cylinder lens to determine the maximum Dyop clarity (via further reduced blur) as the **optimum Axis setting**.

4. Reduce the Dyop diameter for the **IRS sphere** to determine the **optimum Axis** where the Dyop is still detected as spinning. This avoids the preference for an under-plused refraction (especially as preferred by a hyperope).

5. With the **IRS Sphere** and the **optimum Axis** setting, adjust the cylinder in 0.25 diopter increments (as either – or + based on the initial findings) to determine if the spinning Dyop becomes clearer. If the Dyop becomes blurrier, reverse the selection to remove or add 0.25 diopters of **Cylinder** to find the optimum **Cylinder** setting.

6. With the optimum **Cylinder** (and **Axis)** determined, again **reduce the Dyop diameter to the smallest arc width** where the direction of spinning can be detected. Then incrementally adjust the Sphere with either (-) 0.25 diopters (myope) or (+) 0.25 diopters (hyperope) to determine if the spinning Dyop becomes clearer or blurrier. If the spinning Dyop becomes blurrier, adjust the sphere by either (-) 0.25 diopters (myope) or (+) 0.25 diopters (hyperope) to make the spinning as clear as possible. Refine (validate) the **Cylinder** by adjusting in increments of 0.25 or 0.125 diopters of **Cylinder** and (+/-) 0.25 or 0.125 diopters of **Sphere** to optimize the Dyop values and reduce the Dyop arc width diameter to where spinning is still detected.

7. The refraction endpoint will be the optimum setting for sphere, cylinder, and axis for the **smallest Dyop angular arc minute diameter** where the direction of spin can be detected. Note that a **STATIC Dyop** will seem to get "clearer" with an overminus. When you **overminus a myope** OR **overplus a hyperope** the **SPINNING Dyop will get less clear.** You want spin direction detection of the **SPINNING** Dyop to be as clear as possible.

8. Record the **Dyop Best Visual Acuity (DBVA)** in **Dyop arc minutes** or as the **Snellen ratio** or **Metric ratio**. Repeat the process for **each eye and binocularly**.

Dyop Test Setup:

To properly ensure monitor calibration and patient viewing distance, use the **Chart2020 Setup Menu** (Keystroke "F10") before using the tests. Save and Exit to return to the tests. The Dyop test screen **Upper Left Corner** displays options for **Sloan Feet/Metric**, or **LogMAR**, or **Decimal** values. The Dyop test **Lower Left Corner** displays the **Dyop arc minute (am) diameter.** Use a **Mouse Scroll Wheel**, **IR controller**, **screen indicator icons**, or the **Keyboard Arrows** to adjust the Dyop diameter. Using Dyop Arc Minutes is more precise than Snellen feet or meters. At each step, reduce they Dyop diameter as much as possible. The refraction sequence is initial Sphere, Axis, Cylinder, readjust the Sphere, then readjust the Cylinder.

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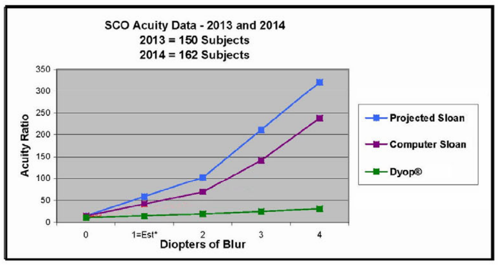
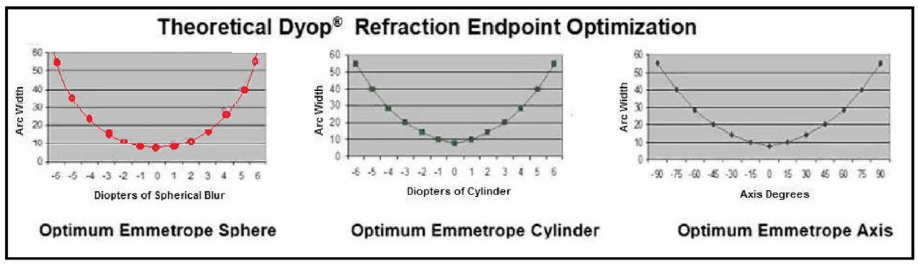
The **Dyop optimum emmetrope** equivalent to Snellen 20/20 (6/6) acuity has an angular arc width of **7.6 arc minutes,** a 10% stroke width, and spins at 40 revolutions per minute. The stimulus gap of that optimum Dyop correlates to a visual stimulus **AREA** of **0.54 arc minutes squared** (the Minimum **AREA** of Resolution or **MAR**) versus the traditional Snellen/Sloan/Landolt visual stimulus **AREA** of 1.0 arc minute squared. The smaller Dyop **MAR** results in its being significantly more precise than the Snellen **MAR,** and having a linear, rather than a logarithmic, increase in size with increasing blur. That linearity also allows a Dyop to have an "optimum" (minimum) acuity endpoint for measuring refractive sphere, or cylinder, or axis regardless of myope or hyperope.





Dyop Refraction Terminology: An emmetrope **Dyop** comparable to **Snellen 20/20 (6/6)** has zero sphere, zero cylinder, and zero axis. The difference from that optimum emmetrope Dyop, with a (rounded) diameter of 8 arc minutes, correlate to an increase of **one diopter of power**, either plus OR minus for every **6 arc minutes** in diameter. The **UDA** in **arc minutes (am)** is the smallest **Dyop** diameter where spinning can clearly be detected. The **ECV** is calculated by **subtracting 8** (the rounded initial **am** value) from the **UDA arc minute (am) value.** The **IRS +/-** in diopters is a linear equivalent to the **ECV. Divide the ECV by 6** to calculate the **IRS**, and then **round that IRS** value to the nearest quarter of a **diopter**. Using **Optometry nomenclature**, the **IRS diopter** value will be **plus (+) for a hyperope** and **minus (-) for a myope**. Confirm the correct +/- **IRS** setting because an **incorrect plus (+) or minus (-) IRS lens will make the spinning Dyop blurrier (less visible) rather than clearer**. Typically start with the **right eye** then the **left eye** followed by a **binocular** refraction. The formula for spherical lens power is **IRS (diopters of blur) = ECV/6 = (UDA-8)/6**.

Examples: A **UDA** of **14** arc minutes corresponds to an **ECV** of **6 arc minutes** and **1 diopter** of **IRS** sphere, as either plus (+) or minus (-). A **UDA** of 26 arc minutes will be an **ECV** of **18** arc minutes and **three** diopters of **IRS** sphere. **Reducing the Dyop diameter to sub-acuity (where Dyop spinning is NOT detected) is equivalent to adding blur to the Snellen test or selecting a smaller size acuity line to test for false positives.**