Dyop® Refraction Procedure

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A Dyop® (short for **dy**namic **op**totype) is a segmented ring visual target whose spinning gaps/segments create a **strobic stimulus** of the photoreceptors of the retina. The detection of spinning is a result of a Dyop using **Resonance Acuity**, much like the visual equivalent of a tuning fork. The spinning Dyop acuity endpoint is **the smallest angular diameter (arc width) of the Dyop ring where the direction of spin is detected** (with the actual clockwise or anti-clockwise direction of spin being irrelevant). **A sub-acuity Dyop** has gap/segments which are blurred or "**twinkle**" rather than having a clear **spinning direction.** The spinning Dyop **resonates** with the saccade induce vibrations of the photoreceptors to facilitate its being used measuring acuity and refractions.

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

The following table illustrates the relationship to the Unaided Dyop Acuity (UDA) endpoint to the corresponding diopters of blur.

UDA = initial Unaided Dyop Acuity (arc minutes) ECV = Emmetrope Comparison Value (arc minutes) IRS = Initial Refraction Setting (diopters)

UDA arc minutes minus 8 arc minutes = ECV arc minutes ECV arc minutes divided by 6 = IRS 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

Dyop refraction steps:

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 arc width detected as spinning. Check for false positives by alternating the Dyop spin direction and location. Subtracting 8 arc minutes from the **UDA** determines the **Emmetrope Comparison Value** (**ECV**). The **ECV** value, when divided by six, determines the **Initial Refraction Setting (IRS) in diopters.** The appropriate **IRS** diopters of sphere (either + or -) **will make the Dyop appear clearer**. An **incorrect** (– or +) sphere will make 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 reduced blur) as the **optimum Axis setting**.

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

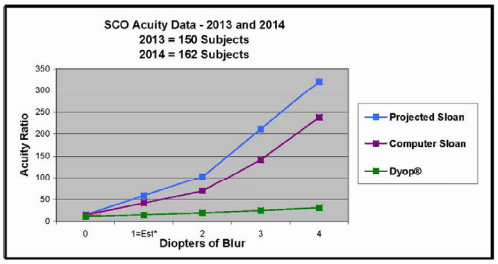
5. With the **IRS Sphere** and the optimum **Axis** setting, adjust the cylinder in 0.25 diopter increments (either – or + based on the initial findings) to determine if the spinning Dyop becomes clearer. If the Dyop becomes blurrier, reverse the selection to remove or add 0.25 diopters of **Cylinder**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

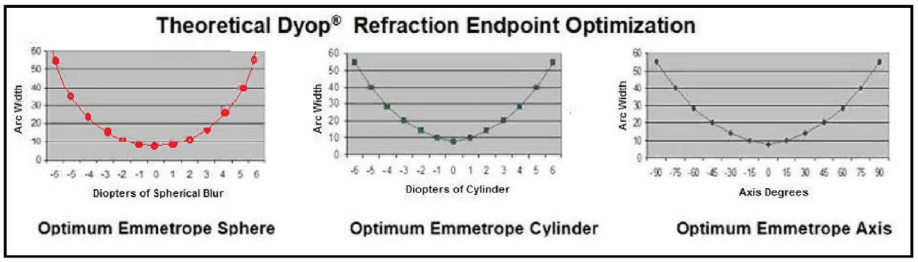
6. With the optimum **Cylinder** (and **Axis)** determined, again **reduce the Dyop diameter to the smallest arc width** where the direction of spinning can be detected. Then incrementally adjust the Sphere with either (-) 0.25 diopters (myope) or (+) 0.25 diopters (hyperope) to determine if the spinning 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 where spinning is still detected.

7. The refraction endpoint will be the optimum setting for sphere, cylinder, and axis for the **smallest Dyop 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 **arc minutes** or as the **Snellen ratio** or **Metric ratio**. Repeat the process for **each eye and binocularly**. With practice, it should be possible to have **a Dyop refraction completed in 90 seconds** or less per eye, but with the increased precision and consistency of a Dyop versus the use of a static optotypes.

The **optimum** emmetrope **Dyop** 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 allows a Dyop to have an "optimum" (minimum) acuity endpoint for measuring refractive sphere, or cylinder, or axis.





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

Dyop Refraction Terminology: 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.**