Dyop® Refraction Procedure

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A Dyop® (pronounced "di-op" and short for dynamic optotype) is a segmented ring visual target using Dynamic Resolution Acuity and whose spinning gaps/segments create a strobic stimulus which resonates with the refresh rate of the retina cone photoreceptors. The detection of spinning of a Dyop is akin to the visual equivalent of a tuning fork to facilitate its use 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 spin direction being irrelevant). A subacuity Dyop has the gaps/segments blurred or "twinkling" rather than having a clear spin direction. However, unlike static Snellen optotypes, the Dyop diameter has a linear relationship of the diameter increase to diopters of blur (rather than logarithmic), and with the potential of a Dyop refraction being completed in 90 seconds or less per eye with both significantly greater precision and consistency. Reducing the Dyop to a sub-acuity diameter (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.

The table below illustrates the conversion of the <u>Unaided Dyop Acuity</u> endpoint (<u>UDA</u>) to diopters of blur <u>IRS</u>. UDA = Unaided Dyop Acuity in arc minutes

ECV = Emmetrope Comparison Value = UDA minus 8 arc minutes

IRS = Initial Refraction Setting in diopters rounded to (+/-) 0.125 diopters = ECV in arc minutes divided by 6 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	65	50	550	47	5 4	400	350	300	250	220	20	00	170	150	130	110) 100
Metric ratio = 6 / XX	600	400	300	240	20	00	170	14	5 '	120	100	90	75	67	6	0	50	45	40	34	30
Unaided Dyop Acuity arc min = UDA	104	81	70	62	5	7	52	47		41	39	35	32	30	2	8	25	24	22	21	20
Emmetrope Comparison Value arc min = ECV	96	73	62	54	4	9	44	39		33	31	27	24	22	2	0	17	16	14	13	12
Initial Refraction Setting (+/-) = IRS diopters	16	12.125	10.375	9	8.1	125	7.375	6.37	5	5.5	5.25	4.5	4	3.5	3.:	25	3	2.5	2.25	2.2	5 2
Snellen/Sloan ratio = 20 / XX	90	80		75	70	65	(50	50		45	40	3	2	25	20	18	3	15	10	6
Metric ratio = 6 / XX	27	25		23	21	20	1	18	15		14	12	9	.5	7.5	6	5.	5 4	1.5	4	2
Unaided Dyop Acuity arc min = UDA	19	18		17	16	15	1	14	13		12	11	1	0	9	8	7		6	5	4
Emmetrope Comparison Value arc min = ECV	11	10		9	8	7		6	5		4	3	2	2	1	0	-1		-2	-3	-4
Initial Refraction Setting (+/-) = IRS diopters	1.75	1.62		1.5	1.25	1.25	5	1	1		0.75	0.5	0.3	875	0. 25	0	-0.2	25 -0	.375	-0.5	-0.75

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

The linear increase of the Dyop 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 <u>Unaided Dyop Acuity</u> (<u>UDA</u>) as the smallest diameter Dyop angular arc width detected as spinning. That minimum Dyop diameter can be verified by reducing the diameter to the sub-acuity diameter (spin not detected) and then incrementally increasing the diameter until one of the Dyop duo IS detected as spinning. False positives may be determined by alternating the Dyop spin direction and/or location.

3. Subtracting 8 arc minutes from the <u>UDA</u> determines the <u>Emmetrope Comparison Value</u> (ECV). That <u>ECV</u> value, when divided by six, determines the <u>Initial Refraction Setting</u> (IRS) in diopters. The correct <u>IRS</u> diopters of sphere (either + or -) will make the Dyop appear clearer. An incorrect (– or + incremental change) in sphere will make the Dyop blurrier.

4. With the correct initial (– or +) <u>IRS</u> spherical diopter lens in place, **verify the axis** by adding **- 0.50 diopters** or more of cylinder. Rotate that cylinder lens to determine maximum Dyop clarity and then reduce the Dyop diameter to **sub-acuity** and then increasing it to the acuity endpoint to determine the **optimum Axis setting**.

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

5. With the <u>IRS</u> Sphere and the optimum Axis determined, 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. Verify the Cylinder setting by reducing the Dyop diameter to sub-acuity and then increasing it to the acuity endpoint.

6. With the optimum Cylinder (and Axis) determined, again reduce the Dyop diameter to sub-acuity and then incrementally increasing the 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. Verify the final sphere setting by reducing the Dyop diameter to sub-acuity and then increasing it to the acuity endpoint.

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) preferably in Dyop arc minutes or as the Snellen ratio or Metric ratio. Repeat the process for each eye and binocularly.

Dyop Test Setup:

Prior to attempting acuity or refraction testing, properly insure the monitor calibration and patient viewing distance. Use the <u>Chart2020 Setup Menu</u> (Keystroke "F10") before using the tests. Save and Exit to return to the tests. The Dyop test screen displays in the Upper Left Corner options for Sloan Feet/Metric, 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 (checking for the subacuity threshold). The refraction sequence is initially Sphere, Axis, and Cylinder, readjusting the Sphere, and then readjusting the Cylinder. If done properly, the Dyop refraction sequence should still take approximately 90 seconds per eye.

The precise **Dyop optimum emmetrope** equivalent to Snellen 20/20 (6/6) acuity in the Precision Mode (Keystroke "P") has an angular arc width of **7.6 arc minutes**, a **10%** stroke width, and spins at **40** revolutions per minute. The gap of that optimum Dyop correlates to a stimulus **AREA** of **0.54 arc minutes squared** (the Minimum **AREA** of Resolution or **MAR**) versus the traditional Snellen/Sloan/Landolt average 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 the subject being a 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 <u>UDA</u> in arc minutes (am) is the smallest **Dyop** diameter where spinning can clearly be detected. The <u>ECV</u> is calculated by **subtracting 8** (the rounded initial am value) from the <u>UDA</u> arc minute (am) value. The <u>IRS</u> +/- in diopters is a linear equivalent to the <u>ECV</u>. **Divide the <u>ECV</u> by 6** to calculate the <u>IRS</u>, and then round that <u>IRS</u> value to the nearest quarter of a diopter. Using **Optometry nomenclature**, the <u>IRS</u> diopter value will be plus (+) for a hyperope and minus (-) for a myope. To confirm the correct +/- <u>IRS</u> setting, an incorrect plus (+) or minus (-) <u>IRS</u> 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 <u>IRS</u> (diopters of blur) = <u>ECV/6</u> = (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.