SUBJECTIVE REFRACTION: A NEW VECTORIAL METHOD FOR DETERMINING THE CYLINDER (2/3)

The refraction technique traditionally used to determine the corrective cylinder for a prescription has changed very little over the years, mainly due to the limitations imposed by subjective phoropters, which present lenses in increments usually no smaller than 0.25 D.
Today, thanks to phoropters with continuous power changes that allow to simultaneously and accurately act on sphere, cylinder and axis, it is now possible to develop new refraction techniques. This series of three articles describes the principles of a new vectorial method for determining the corrective cylinder and presents the rationale for an associated automated cylinder search algorithm.

Hélène Starynkevitch
R&D Research Study Manager
Instruments Division
Essilor International

Hélène Starynkevitch earned an opticians degree from the Institut et Centre d'Optométrie (ICO) in Bures-sur-Yvette, France (2013) and studied Health Engineering with an emphasis on Vision Science at the Université d'Orsay Paris Sud XI (2016). She is currently a research engineer in the R&D Department of Essilor Instruments, working to develop methods and algorithms for vision screenings performed with new instruments and to design interfaces for practitioners. Hélène also heads up optometry studies comparing instruments and/or vision screening methods. In addition to this work, she volunteers with VisionSoliDev to provide vision screenings to the disadvantaged.

Gildas Marin
R&D Research Study Manager
Vision Sciences R&D Department
Essilor International

Based in Paris, Gildas Marin PhD is a senior vision scientist at the Essilor Centre of Innovation & Technology Europe and a member of Essilor International's Vision Sciences R&D team. A graduate of the Institut of Optics Graduate School, Gildas completed his training with a doctoral thesis in 1997 at the Institut of Optics together with the Pitié-Salpêtrière Hospital (Paris) in medical imaging. His main research topics are vision modeling, the simulation of optical effects and visual performances, with a particular emphasis on the impact of optical aberrations on vision. More recently, Gildas has worked on improving refraction methodologies. Since 2015, he has managed a research programme on the development and validation of algorithms and methods of precise refraction implemented in the Vision-R™ 800 and AVA™ (Advanced Vision Accuracy) offer.

Dominique Meslin
Refraction Solutions Director
Instruments Division
Essilor International

Trained in France as an optician and optometrist, Dominique Meslin has spent almost all his professional career with Essilor. He started in Research and Development department working on physiological optics studies and then moved to several Technical Marketing and Communication positions for Essilor International, in France and also in the USA. For more than 10 years, Dominique was the Director of Essilor Academy Europe. He then focused on Professional Affairs activities for Essilor Europe. He is now in charge of the new Refraction Solutions for the Instruments Division of Essilor International. All over his career Dominique has conducted many training seminars for the Eye Care Practitioners. He is the author of several scientific papers and many Essilor technical publications, including the "Ophthalmic Optics Files" series.

KEYWORDS
Subjective refraction, vectorial refraction, dioptric space, cylinder search, cross cylinders, phoropter, refraction algorithm, Vision-R™ 800.

Following up on our first article, published in Points de Vue in November 2020, we continue our discussion of a new vectorial method for determining the cylinder. This second article compares the techniques used in "traditional" refraction with a new "digital" refraction method for determining the cylinder axis and cylinder power during a refraction examination.

3) Determining the cylinder: "Traditional Refraction" vs "Digital Infinite Refraction™"

In "traditional" refraction, the cylinder axis is always determined before the cylinder power. Let us take a look at each of them, comparing the "traditional" and "digital" methods for testing the axis and power.

a) Cylinder axis test:

- ***With "traditional refraction" technique***

The Jackson cross-cylinder technique is the most universal method for determining the cylinder axis of a correction. To do so, the practitioner places the handle of the cross-cylinder according to the direction of the axis of the corrective cylinder to be tested and offers the cross-cylinder to the patient in two positions by flipping it over. The combination of the cross-cylinder power and the residual astigmatism, resulting from the patient's eye and the correction in place, creates a perception of blurriness for the patient. The position of the cross-cylinder that the patient perceives to be less blurry indicates the direction that the axis of the correction should be adjusted in. In this way, with a succession of approaches, the practitioner searches for the position for which the patient perceives no difference in blurriness between two positions; the handle's orientation then indicates the direction of the corrective axis. More details on this traditional refraction technique can be found in a number of reference works.(6)

(*) Vision–R™ 800 phoropter with smooth power changes by Essilor Instruments

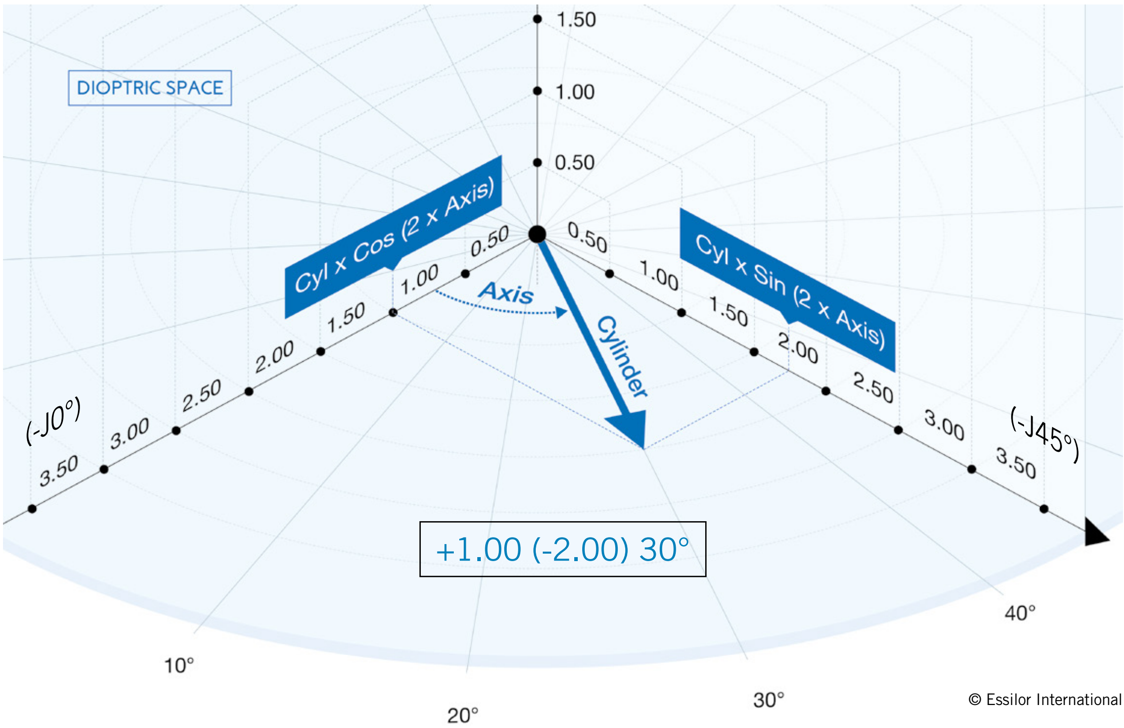

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Figure 2: Vectorial representation of refraction in a Dioptric Space.
Cartesian coordinates: example of a refraction formula of +1.00 (-2.00) 30°

If we consider the example of Figure 2, showing a prescription of +1.00 (-2.00) 30°, the handle of the cross-cylinder is oriented to 30° and two positions of the cross-cylinder are being tested (see Figure 3): Position 1, with the negative axis of the cross cylinder at 165° (30° - 45° modulo 180°) and Position 2, with this same axis positioned at 75° (30° + 45°). The practitioner thus tests the results of two combinations of the cross-cylinder with the correction in place, for which the formulas are as follows: Position 1, +1.03 (-2.06) 23°, and Position 2, +1.03 (-2.06) 37°, i.e. for the example of a 2.00 D cylinder, an axis variation of 7° on either side of the corrective cylinder axis being tested (see Table 2). The patient then indicates which Position he/she prefers or, more specifically, which one is less blurry. Let us suppose that he/she prefers the second position. Traditionally, the practitioner then rotates the axis of the correction 5° and the cross-cylinder in the direction indicated, taking them to 35°, and performs the test again in the same way. He/she offers two combinations that are identical to the previous ones, with the resulting axis again situated at 7° on either side of the new axis direction tested, namely 35° tested, or +1.03 (-2.06) 28° for Position 3 and +1.03 (-2.06) 42° for Position 4. They continue in this way until the patient no longer perceives any difference between the two positions or asks to go back to an earlier axis direction.

At this point, we can make the following observations:

- In the "dioptric space", the effects of the cross-cylinder during the axis test are expressed perpendicularly to the direction of the vector representing the correction being tested, with a 0.50 D variation on either side (see Figure 3). In this test, the spherical equivalent power remains constant, since the spherical equivalent power of the cross-cylinder is null. Thus, any search for the axis takes place on the cylinder plane, J0° / J45° (or on a parallel plane if the spherical equivalent power of the chosen correction was not null).

- It is clear that when one is testing the axis of a corrective cylinder using a cross-cylinder, one is actually testing the effect that the cross-cylinder power induces on the axis of the resulting cross-cylinder + corrective cylinder when the cross-cylinder is positioned at 45° on either side of the axis of the corrective cylinder. In the example of a cylinder of (- 2.00) at 30°, one tests the effect of a +/- 7° variation in the axis on either side of the 30° direction, in other words 23° and 37°, caused by a 0.50 D cylinder oriented at +/- 45° with respect to the 30° axis (165° and 75° respectively).
  For other cylinder power values, one would test other angle values: a few examples can be seen in Table 2, which presents tested axis variations with cross cylinders of +/- 0.25 D and +/- 0.50 D according to the cylinder power. We can see that the tested angle effect, expressed in degrees, is inversely proportional to the cylinder's value, which is perfectly consistent with the fact that patients are especially sensitive to cylinder axis variations when the corrective cylinder power is higher. But this effect, expressed in dioptric terms, remains constant because it is the value of the cross cylinder used (here, 0.50 D), which guarantees uniformity of perception in the optical effects observed by the patient during the search for the cylinder axis.

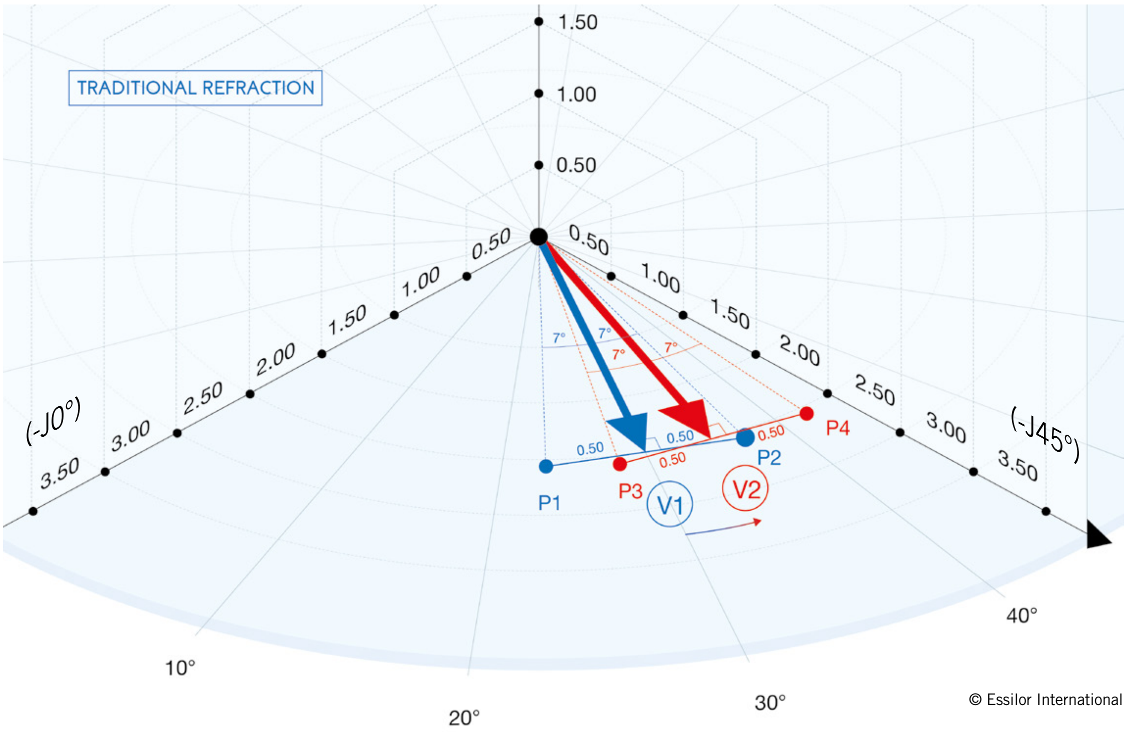

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Figure 3: Cylinder axis test in the "Traditional Refraction" technique

Table 2: Tested axis variations with cross cylinders of +/– 0.25 D and +/– 0.50 D. Depending on the powers of the cross cylinder and cylinder, it is expressed in the formula: *Tested Axis Variation = ½ * Arc Tan (Cross Cylinder Power / Tested Cylinder Power)* ie, the values presented in the following table.

Power Cylinder Tested (Diopters)	Tested Axis Variations (Degrees)	
	With CC +/- 0.25 (Cyl 0.50)	Avec CC +/- 0.50 (Cyl 1.00)
0.50	+/- 22.5 °	+/- 31.7 °
1.00	+/- 13.3 °	+/- 22.5 °
1.50	+/- 9.2 °	+/- 16.8 °
2.00	+/- 7.0 °	+/- 13.3 °
2.50	+/- 5.7 °	+/- 10.9 °
3.00	+/- 4.7 °	+/- 9.2 °

– Once the first axis test is made based on the initial direction, the initial correction and cross-cylinder are turned together, for example another 5°, in the direction indicated by the patient in order to re-test the axis in a second direction. At this stage, several effects appear:

1) The effect observed by the patient during an axis test is not completely respected during the following tests. Remember that a cylinder can be considered a lens producing "a given power, at a given axis" and that, as a result, modifying the cylinder axis will modify its corrective optical effect and the patient's perception of it. During the rotation of the corrective cylinder axis between two axis tests with the cross-cylinder, for example by 5°, the cylinder power remains constant. Represented in the dioptric space (Figure 3), the cylinder's axial component is modified without its power component being adjusted, and the cylinder axis rotation, without adjustment to its power, does not keep the test direction of the cylinder's axial component constant. As a result, it does not respect the perception that the patient had of it during the previous axis test: the test conditions are thus modified with each axis rotation. In a certain sense, the information that the patient provides during the first axis test is not fully conserved and respected during the second axis test and other tests to follow. The various answers the patient gives under different conditions lack consistency and it is not possible to accumulate them and capitalise on previous answers to fine-tune the search for the cylinder axis and determine it accurately.

2) The axis system of reference in the dioptric space changes throughout the axis search process. After the 5° axis rotation, the second axis test is performed with reference to the new cylinder direction, in a new combination with a cross-cylinder oriented to 45° on one side (Position 3) of this direction and the other (Position 4). In the dioptric space, this test is carried out in a direction perpendicular to the new cylinder direction, which has been turned 5° and therefore in a direction that has also been turned 5° compared to the previous test direction. The system of reference is thus modified compared to the one used during the first cylinder test. It will then be modified with each change in the orientation of the cylinder axis tested throughout the process of determining the cylinder axis. As the system of reference has changed with each axis direction modification, the axis test conditions lack consistency. In this way of proceeding, it is not possible to determine the cylinder axis independently of its power or to guarantee the independence of the two cylinder components that we are trying to determine. This is one of the accuracy limitations in "traditional" refraction when it comes to searching for the axis.

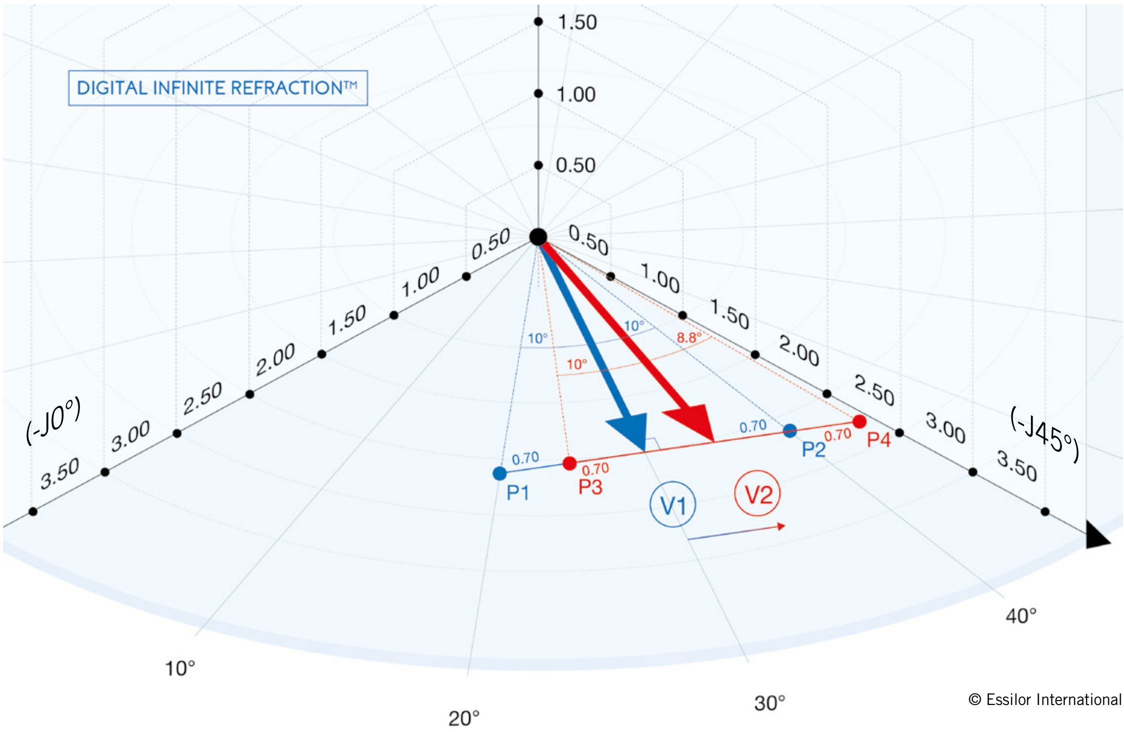

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Figure 4: Cylinder axis test using the "Digital Infinite Refraction™" technique

3) <u>The dioptric increment used to determine the cylinder axis varies according to the cylinder power and is not consistent with the one used to determine the cylinder power.</u> The rotation effected between one axis test direction and another is left to the discretion of the practitioner. In practice, it is often constant, for example 5°, and not adjusted according to the cylinder power. Its dioptric effect, which is to say the translation in optical power of the axis rotation, is therefore variable and translates to the use of dioptric increments that vary according to cylinder power (see Table 3 on the dioptric effect of a cylinder axis rotation according to the cylinder power).
Moreover, these increments are not consistent with the dioptric increment used for changes in cylinder power, which is (-0.25) D. For the patient, this leads to a lack of uniformity in the effects of perception between the searches for the cylinder axis and cylinder power. As a result, the precision obtained in determining the axis is rarely equivalent to that obtained for the power and is often inferior to it. Once the cylinder power exceeds 1.25 D, a 5° rotation produces a dioptric effect superior to 0.25 D (see Table 4 presenting the cylinder axis rotation for creating a constant optical effect). This is the accuracy limitation found in the Jackson cross-cylinder method as implemented in the "traditional" refraction technique.
Ideally, to achieve full uniformity in patient perceptions, the axis rotation increment would need to be adjusted according to the cylinder power value so that it corresponds to constant dioptric effects (Table 4). Although experienced practitioners are skilled at rotating the axis according to the power, it is not possible to keep this dioptric increment rigorously constant. As we shall see, the vectorial technique for determining the cylinder, combined with the optical module with continuous power changes, makes it possible to keep this dioptric increment exactly constant and therefore to ensure complete consistency in patient perceptions.

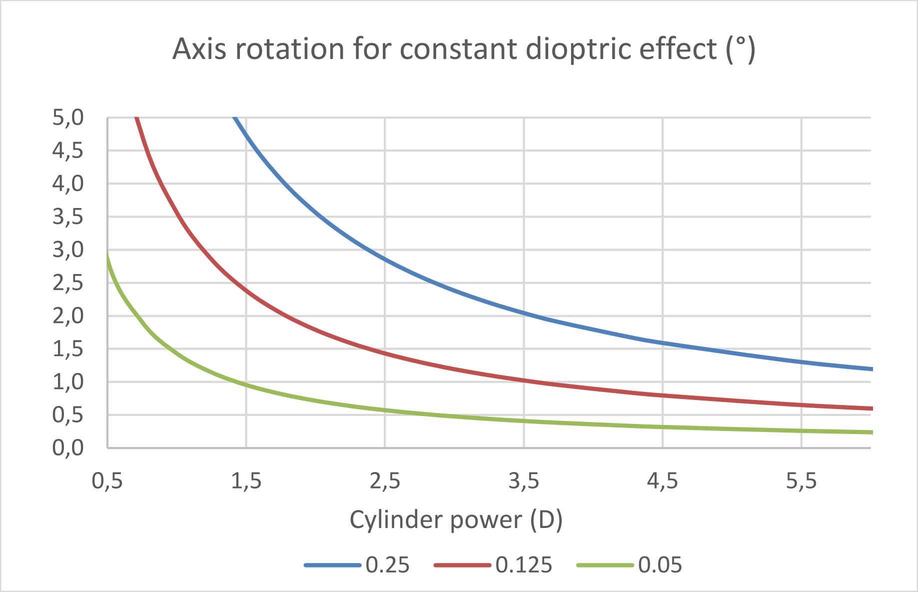
Table 3: Dioptric effect of a cylinder axis rotation. According to the cylinder power and for 3 axis rotations: 5°, 2° and 1°.

Tested Cylinder Power (Diopters)	Cylinder Axis Rotation (Degrees)		
	5°	2°	1°
0.50	0.09	0.03	0.02
1.00	0.17	0.07	0.03
1.50	0.26	0.10	0.05
2.00	0.35	0.14	0.07
2.50	0.44	0.17	0.09
3.00	0.52	0.21	0.10
3.50	0.61	0.24	0.12

For example, a 1° rotation in the axis of a 1.50 D cylinder has a dioptric effect of 0.05 D. If this same cylinder is turned 2°, the effect is 0.10 D and if it is turned 5°, the effect is 0.26 D.

- In the representation shown in Figure 3, a search for the axis using the "traditional" technique translates graphically to the fact that the dimension of Vector 2 (in red) is identical to that of Vector 1 (in blue) rather than being a projection of it, and that the test direction of Vector 2, made perpendicularly, is different from the direction tested for Vector 1. Thus, throughout the process of determining the cylinder axis in the traditional method, the cylinder power remains identical regardless of its orientation, the axis system of reference varies for each orientation of the cylinder and the direction changes made during the cylinder search do not maintain uniformity of perception for the patient. These permanent changes inevitably introduce a bias and are a source of inaccuracy, constituting an intrinsic limitation to precision in the "traditional" technique for determining the cylinder axis.

Table 4: Cylinder axis rotations producing a constant dioptric effect
Depending on the cylinder power and for 3 dioptric effect values (0.25 D, 0.125 D and 0.05 D).



A 5° cylinder axis rotation corresponds to a dioptric effect above 0.25 D as soon as the cylinder power exceeds 1.25 D. Starting with a cylinder power of 3.50 D, the axis rotation should be less than 2° to respect a 0.25 D increment (see the example in the figure): it should be 1° for a 0.125 D effect! The traditional refraction method, in which the axis rotation increment is most often constant in degrees, does not allow the practitioner to keep the dioptric change increment constant during the search for the cylinder axis. The vector method used in "Digital Infinite Refraction^{TM}" does make this possible.

With the "Digital Infinite Refraction™" technique

The digital cylinder axis search technique, which is made possible by phoropters with continuous power changes(*), uses a principle that is similar to the Jackson cross-cylinder method but with several fundamental differences:

1) No cross cylinders are physically present in the phoropter, but optical effects of virtual cross-cylinders are generated in the optical module, as previously explained.

2) The power of the cross cylinder used can be chosen, and therefore varied, and can be configured in the cylinder search algorithm. In the example presented, it is +/-0.35 D, and therefore has the formula +0.35 (-0.70).

3) Any dioptric effect induced by a modification with the corrective cylinder axis is automatically adjusted in the cylinder power and, as a result, compensated in the sphere power. This adjustment is made very precisely in 0.01 D resolution in such a way that the cylinder axis test direction and spherical equivalent power are kept fully constant throughout the entire test. This is possible due to the properties of the optical module of the phoropter with continuous power changes,(*) which allows to very precisely and simultaneously vary the sphere, cylinder and axis. Thus, the corrective cylinder axis test is performed using an axial component with a constant direction, perpendicular to the initial cylinder direction, and independently of other refraction components, very precisely respecting their values.

If we consider the earlier example of an initial correction of +1.00 (- 2.00) 30°, the axis test begins in the same way as in the "traditional" method. A cross-cylinder power is tested perpendicularly to the direction of the vector representing the initial correction (see Figure 4). As this cross-cylinder has a higher value, namely +/- 0.35 D, the tested axis variations are greater than in the "traditional" method, which more often uses a cross-cylinder of +/- 0.25 D. In the example chosen, the formulas tested are +1.06 (-2.12) 20.4° for Position 1 and + 1.06 (-2.12) 39.6° for Position 2. We can see that for this first test, the tested axis directions are symmetrical with regard to the initial direction tested: -/+ 9.6°. The patient perceives greater differences than in the "traditional" method and can more easily indicate which of the two positions he/she prefers. Let us suppose that the patient prefers the second position and therefore “request” an axis greater than 30°. Next, the algorithm will rotate the corresponding cylinder axis, in this direction and because it is chosen in this way, to a translation of half of the value of the 0.70 D cross-cylinder in the test direction: i.e. 0.35 D.

A fundamental difference compared to the "traditional" method can be observed at this point: management of the refraction via vectorial components results in the dioptric effect of the corrective cylinder axis variation being corrected on the value of the new cylinder and its consecutive effect on the spherical equivalent power is also compensated in such a way that keeps it constant. In other words, rather than keeping an identical cylinder value, it is adjusted to allow a search for the cylinder axis – or, more specifically, the cylinder’s axial component projected perpendicularly to the direction of the initial axis – independently of its effects on the other refraction components and thus to conserve the same test conditions. In our example, the new formula to test becomes +1.015 (-2.03) 35°, where we can observe that the cylinder power has been adjusted by (-0.03) D and the sphere power has been compensated in consequence by +0.015 D.

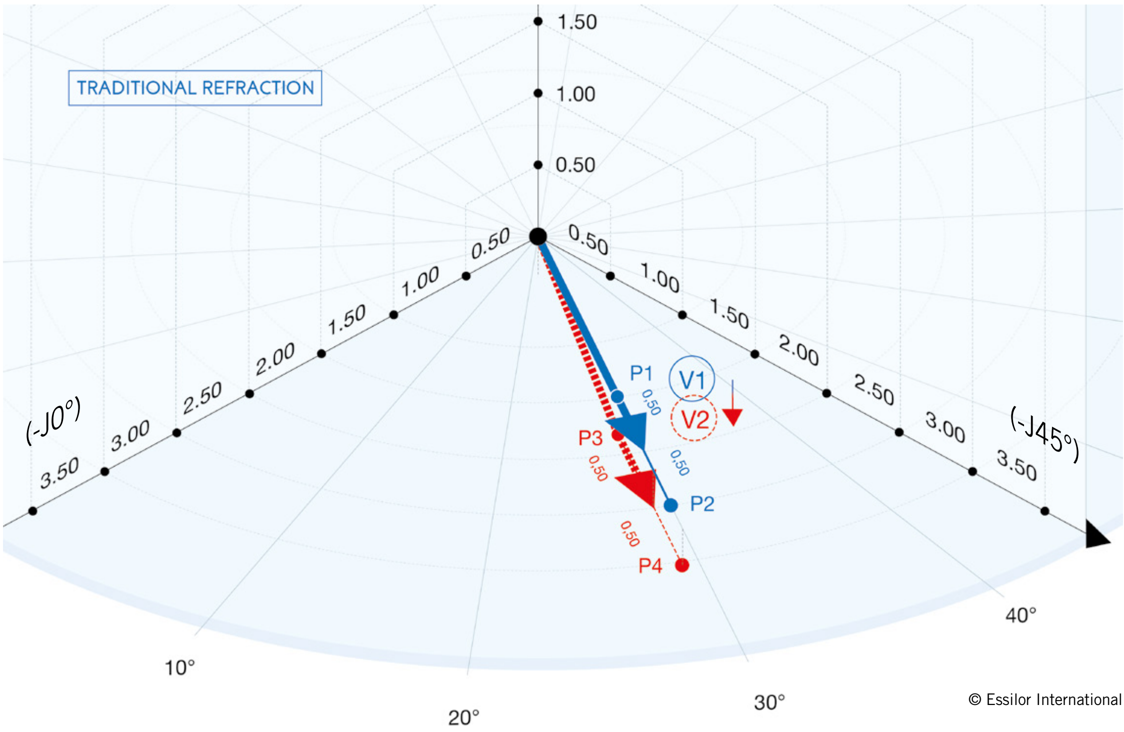


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Figure 5: Cylinder power test using the "Traditional Refraction" technique

Graphically speaking, in Figure 4, searching for the cylinder axis using the digital method translates to the fact that the orthogonal projection of Vector 2 (in red) on the direction of the initial axis corresponds to Vector 1 (in blue) and the direction of the axis search on the J0° / J45° plane remains identical throughout the entire cylinder axis search process, which is to say perpendicular to the initial axis. Thus, the projection of the cylinder power determined according to the initial axis, which corresponds to the cylinder's second vector component, is respected and remains independent of the axial component. The cylinder axis search system of reference is thus kept constant. From a practical point of view, this is why, when the automated cylinder search algorithm is being used, the sphere, cylinder and axis all vary at the same time during any test of the cylinder's axial component.

As previously mentioned, another fundamental difference between the "traditional" and "digital" methods is that the axis modification increment can be chosen so that it is dioptrically identical to the one used to search for the cylinder power. More specifically, the dioptric effect of the axis rotation between two tested axis positions can be exactly the same as the one used during the changes made between two tested cylinder powers, as we will see later on. In our example, a choice has been made to use 0.35 D change increments, corresponding to half of the virtual cross cylinder power of +/- 0.35 D, at least at the beginning, both for the axis orientation changes and for the power changes. The dioptric effects produced during the axis and power searches are consistent and the patient's perceptions of them are uniform. This is an undeniable advantage of the "digital" technique, since it cannot be obtained in the "traditional" technique.

The following axis test is then performed in the same direction as the first test, with an identical cross-cylinder value (although it could be different), tested on either side of the direction of the new cylinder but, this time, with different angular values rather than equal ones as is done in the "traditional" method, in such a way that the dioptric increment is kept constant. In our example, again with a +/- 0.35 D cross-cylinder, the new formulas tested become +1.13 (-2.26) 25.0° for Position 3 and +1.02 (-2.04) 43.8° for Position 4. We can see that they are asymmetrical compared to the tested formula, both in axes and powers, rather than symmetrical as in the "traditional" method. This is what makes it possible to maintain the projection of the axial vector component in a constant direction. And this can be seen quite clearly when we compare Figures 3 and 4.

The search for the cylinder axis proceeds in this way until an inversion in the patient's answers is reached. In other words, the patient either asks for the axis value to be reduced after asking for it to be increased, or vice versa.

Later on we will take a closer look at the way the patient's answers are taken into consideration and the method of evaluating the final refraction value.

b) Cylinder power test:

- ***With "traditional refraction" technique:***

The most common traditional technique for verifying the power of a corrective cylinder involves using a Jackson cross-cylinder to determine whether the cylinder power should be increased or reduced. To do this, the practitioner orients the cross-cylinder in front of the correction in place by positioning its main meridians so that they are in correspondence with the corrective cylinder axis (in other words, by turning the cross-cylinder 45° compared to the orientation previously used to verify the corrective cylinder axis). They present the cross-cylinder in an initial position,

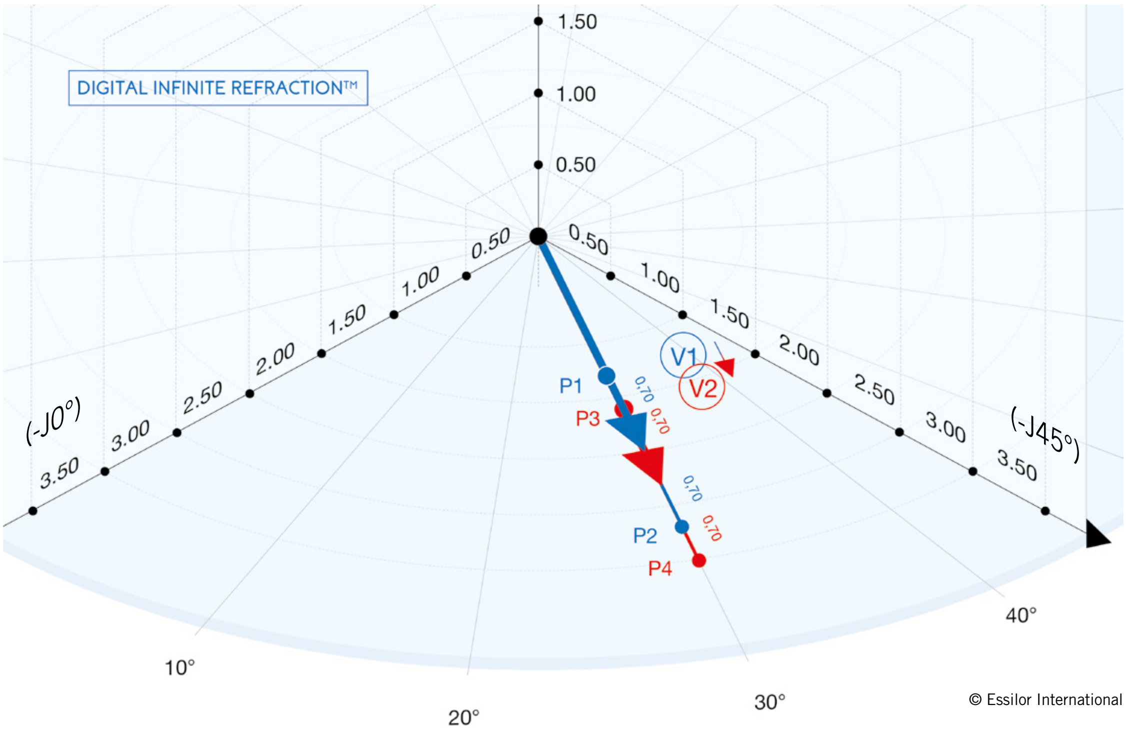

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Figure 6: Cylinder power test using the "Digital Infinite Refraction™" technique

then rapidly turn it over and ask the patient to indicate in which position their vision is clearest (or, more specifically, the least blurry). When the lens is turned over, the + and - axes of the cross-cylinder are inversed and the corrective cylinder power is increased in one position and reduced in the other, without any effect on the mean sphere since the spherical equivalent power of the cross-cylinder is null. Let us suppose that they are using a +/- 0.25 cross-cylinder, and therefore a 0.50 D cylinder. The test described consists of increasing and reducing the cylinder by 0.50 D and asking the patient which he/she prefers.

Let us return to the earlier example of a prescription of +1.00 (-2.00) 30°, testing for cylinder power (Figure 5). The practitioner positions the cross-cylinder with its cylinder axis oriented according to the corrective axis of 30° and turns it over to test the following two positions: for example, Position 1, with the positive axis oriented at 30° and Position 2, with the negative axis oriented at 30°. In other words, the practitioner asks the patient if he/she wants the negative cylinder to be reduced in Position 1 or increased in Position 2. The power combination formulas – for the corrective cylinder and cross-cylinder – that are tested are as follows: +0.75 (-1.50) 30° in Position 1 and +1.25 (-2.50) 30° in Position 2. Let us imagine that the patient wants the cylinder power increased and therefore prefers Position 2. The practitioner then increases the cylinder power by (-0.25) D, according to the minimum increment available in traditional phoropters, which happens to correspond to half of the cross-cylinder power (without there necessarily being any relationship between the two). They then repeat the process. Next, they test the cylinder power of the new correction, with the formula +1.00 (-2.25) 30°, with two options: one reducing the cylinder power by 0.50 D and the other increasing it the same amount, with the formulas +0.75 (-1.75) 30° for Position 3 and +1.25 (-2.75) 30° for Position 4. They continue in this way until the patient no longer sees any difference between the two positions of the cross-cylinder or an inversion is reached in their answers. In other words, the patient asks either for the cylinder power to be reduced after asking for it to be increased or vice versa.

We can make an observation at this point: each time the cylinder power is modified, an undesirable effect is inevitably produced in the spherical equivalent power of the refractive formula, making a sphere adjustment necessary. In the example suggested, if the first correction tested, +1.00 (-2.00) 30°, has a plano spherical equivalent, the second correction tested, +1.00 (-2.25) 30°, will have a spherical equivalent of -0.12 D. A deviation of the spherical equivalent power is thus produced with each modification to the cylinder power. To be able to test the cylinder power independently of the other refraction components, one needs to be able to immediately compensate for the effect induced on the sphere. This is unfortunately impossible with traditional phoropters using lenses in 0.25 D increments. And it is generally only after a modification of (0.50) D to the cylinder power that the mean sphere power can be adjusted by an opposite half-value. Thus, most often, a +0.25 D sphere adjustment is made after each (-0.50) D cylinder is added to the corrective cylinder power. This happens automatically in motorised phoropters.

In the representation of the "dioptric space" (Figure 5), the traditional technique for testing cylinder power can be seen with a reduction (Position 1) or increase (Position 2) in the tested cylinder power. The increase in cylinder requested by the patient translates to an increase in the dimension of Vector V2 (in red) compared to that of Vector V1 (in blue) but, at the same time, by a change in the average power that makes Vector V2 no longer be located on the J0° / J45° plane but on a plane below it. Thus, the J0° / J45° plane for the cylinder search changes with each modification to the cylinder power rather than remaining constant. This is where we find another of the limitations of the "traditional" refraction technique, in which the effects of the cylinder on the sphere cannot be controlled with precision.

With "Digital Infinite Refraction™" technique

The "digital" cylinder power test technique is similar to the "traditional" technique using Jackson cross-cylinders but, as we have already seen, with the following three basic differences:

1) The optical effects of the cross-cylinders are produced by calculation in the optical module, in combination with the existing correction, as explained previously.

2) The value of the cross cylinder used differs from that of the traditional +/- 0.25 and a greater power is used to facilitate the patient's answers. In the example at hand, the value of the cross-cylinder used is +/- 0.35 D, or a formula of +0.35 (-0.70).

3) Any modification to the cylinder power is simultaneously accompanied by an adjustment to the sphere power to keep the spherical equivalent power constant, with a resolution of 0.01 D. Thus, for any modification of (-0.02) D to the cylinder power, an increase of +0.01 D is automatically made to the sphere power.

Let us again consider our example of a +1.00 (- 2.00) 30° correction in which, this time, we want to verify the cylinder power (Figure 6). Again, using the cross-cylinder technique, the idea is to see whether it should be increased or reduced. Since the virtual cross-cylinder power is +/- 0.35 D, the algorithm introduces a 0.70 D cylinder variation, reducing (Position 1) or increasing (Position 2) the existing corrective cylinder. The following refractive formulas are tested: +0.65 (-1.30) 30° in Position 1 and +1.35 (-2.70) 30° in Position 2. We see that the sphere power is automatically adjusted by the opposite half of the cylinder variation introduced, which is also the case in the "traditional" technique. Let us suppose that the patient wants the cylinder increased and therefore prefers Position 2. The algorithm would then modify the value of the corrective cylinder by half of the variation of 0.70 D tested, or 0.35 D, for example, because the value of the increment could be chosen differently. But at this point, at the same time as the corrective cylinder is modified, the power of the sphere is also compensated in order to keep the spherical equivalent power constant. The new correction tested would thus become +1.17 (-2.35) 30°. Note the +0.17 D sphere adjustment, which could not be done in the traditional technique. It would then look for the cylinder power, testing two new powers whose formulas are +0.82 (-1.65) 30° for Position 3 and +1.52 (-3.05) 30° for Position 4. It would then continue in this way until an inversion in the patient's answers is reached, adjusting the sphere power for each modification to the cylinder power.

Graphically speaking, in the representation of the dioptric space (Figure 6), the "digital" cylinder power test technique can be seen, as for the "traditional" technique by a reduction (Position 1) or an increase (Position 2) in the cylinder power suggested, and therefore a proposal to shorten or lengthen the length of Vector V1 (in blue). The increase in cylinder power requested by the patient translates to a lengthening of the dimension of the vector from V1 (in blue) to V2 (in red) but, this time, with a fundamental difference: the mean sphere power is kept constant via its simultaneous adjustment when the cylinder power is increased. In practice, Vector V2 remains on the same plane and the search for the cylinder continues on a single J0° / J45° plane, keeping all other characteristics constant. This is a major difference and a clear advantage with the "Digital Infinite Refraction™" compared to "Traditional Refraction" when it comes to determining a patient's corrective cylinder.

We will continue the presentation and discussion of this topic in a third and last article that will follow.

KEY INFORMATION:

- In the "traditional" refraction method:
  - the cylinder axis is determined on the basis of the current direction of the axis, with dioptrically variable increments in axis rotation,
  - the cylinder power is determined while mean sphere power is varying,

  in other words, under conditions that change throughout the process of determining the cylinder.
- In the new "digital" refraction method:
  - the cylinder axis is determined on the basis of a fixed direction, with dioptrically constant increments of axis rotation,
  - the cylinder power is determined while maintaining the mean sphere power constant,

  in other words, under fixed, consistent conditions throughout the process of determining the cylinder.
- Thus, the testing technique used in new "Digital Infinite Refraction™" allows for a more precise determination of the corrective cylinder.

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