PROGRESSIV R: The new progressive lens from Rodenstock *

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A year ago we presented a new, improved progressive lens with 'variable surface periodicity'[1]. That presentation consisted largely of a discussion of the surface theory; here the emphasis will be on the application side of the 'Progressiv R' lens which is based on this surface concept.

First, however, we must recapitulate some points in order to link those earlier and chiefly theoretical considerations to the practical conclusions. The mathematical approach on which the concept of surfaces with variable periodicity is based, makes it possible, within wide limits, to design or reproduce any desired surface. Thus, in a highly systematic process, we were able to realise the Progressiv R concept—a concept which avoids the disadvantages of other such lens types or shows them to a lesser degree. The features of this new concept include:

1. A wide progression corridor.
2. The fact that the peripheral surface astigmatism, which is in principle unavoidable, is reduced extensively and any variation in amount and orientation is spread smoothly over the surface.
3. The desire for extended near and distance vision fields which would also be free from image flaws.

In accordance with this concept the primary visual zones have been kept as free as possible from aberration. Despite this it was possible to reduce the peripheral astigmatism substantially, as is demonstrated overleaf in Fig 1. The course of the iso-astigmatism lines and of lines of equal mean power permit the characteristic features of the surface formation to be recognised without difficulty.

The surface is constructed symmetrically to the main meridian, which represents an umbilic line; the progression corridor is wide and has, away from the distance portion, a 'funnel' which makes a valuable contribution to wearing comfort. The peripheral astigmatism remains small since, even for movements of the eye up to 30°, it hardly ever attains a value over that of the near addition. Even in the periphery the distance portion shows practically no image flaws; and finally, the near segment is comparatively large and shows constant width.

Optical properties of Progressiv R

Peripheral zone

The extent to which the wearer will become used to progressive lenses and find them comfortable to wear depends not only on the width of the progression corridor but also substantially on the image quality in the peripheral zone. The photograph of a grid pattern (Fig 2, overleaf) shows how small the lateral distortions are with Progressiv R—even with a high addition of 3.0D. It is true that such grid pattern photographs are useful only for qualitative statements but, nevertheless, they give a very clear picture of the distortions produced through progressive lenses with static vision. This is how, for example, a tiled wall would look to a spectacle wearer with Progressiv R lenses. Fig 2 shows clearly how well the orientation of the vertical and horizontal grid pattern lines is retained, i.e. even in the more distant areas of the lens Progressiv R only shows a low oblique distortion.

In particular the yellow-coloured vertical meridian and the horizontal meridian—which pass through the centering cross—are unaffected by the 8° rotation of the near portion. From this it can be concluded that it is not necessary to design asymmetric progressive surfaces. This is because the effect for the patient is practically the same whether the inset of the near segment is obtained with a straight main meridian, which is inclined by rotation of the lens, or one which is inclined inwards by construction for both left and right lenses.

The orientation of astigmatism in the peripheral zone of the lens in Fig 3 is the explanation for the minimal distortion of the square grid cells which was shown in Fig 2. Resulting from physical laws, axis orientations of 45° or 135° can be seen close to both sides of the main meridian in the progression corridor—as with every progressive lens with an umbilic line. In the near vicinity of the umbilic line the amount of the astigmatism begins to increase; but only slowly at first so that—as is the case for all low cylinder powers—the oblique axis orientation has no real significance. For large angles of view the amount of surface astigmatism does, of course, become significant; but with increasing astigmatism the axes move to become perpendicular to the umbilic line. Thus in Progressiv R the peripheral zone, which is so important for general orientation, remains almost completely free of oblique distortion.

Progression corridor

Because of the symmetrical construction of the surface, the main meridian is a flat curve and also has the properties of an umbilic line; i.e. surface elements along the main meridian are spherical at every point so the progressive corridor remains free of astigmatism. As shown in Fig 4 the power increases along the umbilic line. Typical features are the marked stabilisation in the near and distance portion and the fact that the power increase above the lens centre G is very low. This results in a wide, comfortable transition from the distance portion into the progression corridor, as can be seen clearly in Fig 1. Nearer to the reading portion the optical power increases at an almost constant rate. The lengthy power increase in the progression corridor provides the spectacle wearer with a sufficiently large vision field for the intermediate distances.

Near portion

Because of the good stabilisation, Progressiv R has at B_N even with high additions, the full power of the reading portion. It also remains constant beneath it and so provides an extended quasi-spherical near vision field. For lower near additions the stabilised near segment begins 1 to 3mm above the near reference point. With respect to the width of the near portion, wearers of Progressiv R say that with a near addition of 2.0D an average of four newspaper columns can be read clearly without moving the head. This is roughly the same result as that obtained by lens types which have been

*Based on a lecture given by Dr Guilino at the 33rd WVAO Annual Congress in Berlin in May 1981.

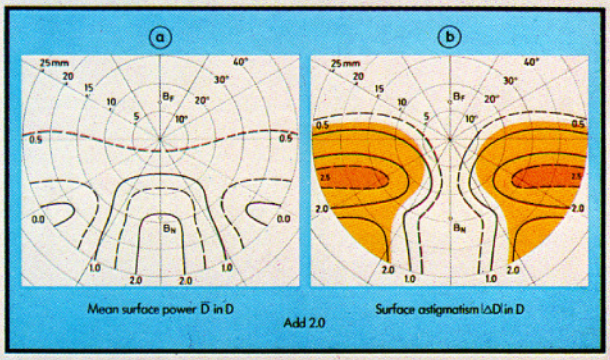
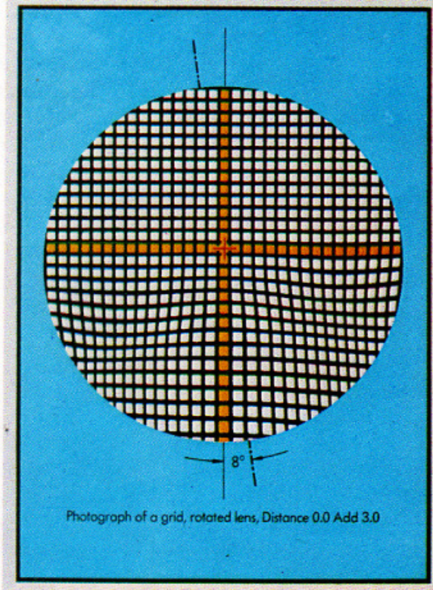


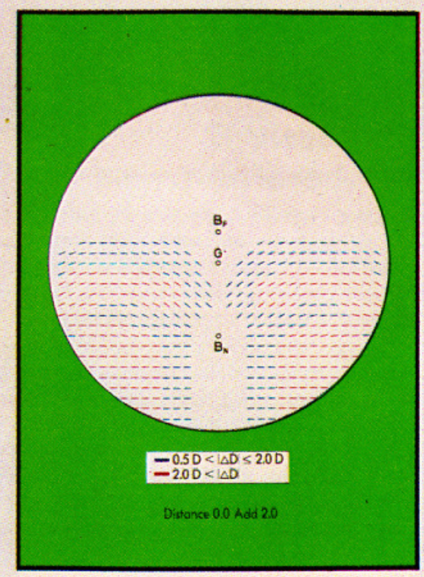
Fig 1 (left): Surface properties of Progressiv R. Left (a): Lines of equal mean surface power. Right (b): Lines of equal surface astigmatism. B_F=Distance reference point; B_N=Near reference point. Origin of coordinates=geometrical lens centre G

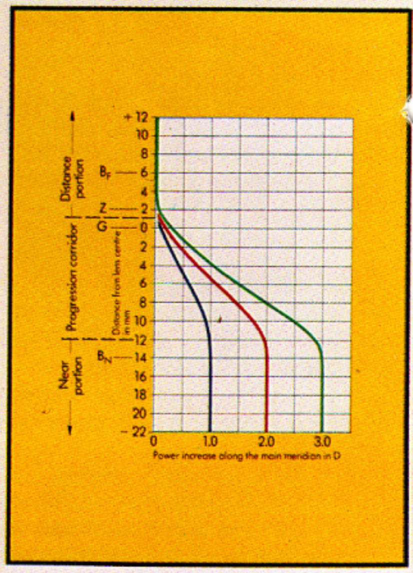
Fig 2 (below, left): Grid pattern photographed through a Progressiv R lens rotated 8° to the perpendicular. The red cross corresponds to the position of the centering cross. The dotted line shows the direction of the main meridian

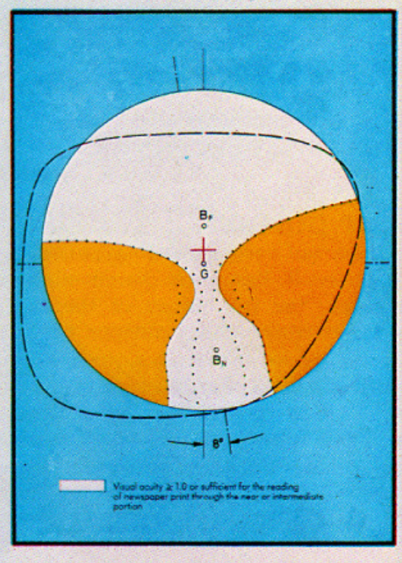
Fig 3 (below, centre): Orientation of the surface astigmatism Δ D (plus cylinder) in Progressiv R for astigmatism greater than 0.5D and for a near addition of 2.0D. The field corresponds to a lens diameter of 70mm

Fig 4 (below, right): Power increase along the main meridian for Progressiv R. B_F = Distance reference point; B_N = Near reference point. G = Geometrical lens centre; Z = Centering cross









designed specifically for a wide near portion and consequently suffer from other compromises.

Distance portion

Grid pattern photographs, as in Fig 2, are not suitable for judging the image quality of the distance portion. However, firm conclusions can be made by determining the visual acuity of the lens at different viewing angles. Reiner[2] has also shown this. Fig 5 reproduces those lens areas through which high acuity vision is possible. The circular field in Fig 5 represents viewing angles of up to 50° (equivalent to 50mm diameter).

Additionally, to demonstrate the practical situation, a lens shape of 54 x 46 has been introduced into the picture. The yellow areas represent those lens zones in which aberrations noticeably reduce visual acuity.

Fig 5: Areas of clear vision based on subjective visual acuity measurements for Progressiv R, with add 2.5D. The edge of the circular area corresponds to a viewing angle of 50°

The visual acuity was determined with equipment for examining the image quality of spectacle lenses as suggested by Reiner. Within the inner dotted lines the visual acuity is above or equal to 1.0; within the outer dotted lines it is above or equal to 0.4.

Because the demands on distance vision are high, we chose as our criterion an acuity value of 1.0. However, those lens areas which have a vision acuity of less than 1.0 are still adequate for many vision requirements. In this connection we should remember that, for example, in West Germany a minimum visual acuity for the better eye of only 0.5 is required for a driving licence. Furthermore, we can see in Fig 5 that the total temporal area 1-2mm above the horizontal lens axis allows high visual acuity for the wearer. Due to the inset of the near portion the zone of somewhat lower image quality necessarily protrudes a little further into the distance portion nasally. But binocular vision is still determined by the better, i.e. temporal, visual perception because only temporally does the normal visual field extend far enough for general orientation, while on the nasal side there is always a closer limitation imposed by the nose and the shape of the head.

The fact that the yellow-coloured area in Fig 5 intrudes higher into the distance portion in the nasal side is not a consequence of the symmetrical surface design, but rather a result of the decentration of the near portion. With an asymmetrically designed progressive surface the aberrations must also be allowed to penetrate further into the nasal part of the distance portion than into the temporal. Otherwise the peripheral distortions on the nasal side would become too strong.

Normally, near vision requires less visual acuity than distance vision. Hence the field within the outer dotted lines corresponds to a visual acuity sufficient for reading newspaper print.

Of particular note is the good correlation which exists between the lines of equal visual acuity (dotted), which are obtained by careful subjective measurements (see Fig 5), and the border line of the yellow field in Fig 1. This border line was calculated from the 'hill' of iso-astigmatic curves, taking into account the well known fact that an uncorrected astigmatism of 1.0D reduces the visual acuity by about 50 per cent. The good correspondence between Figs 1 and 5 proves that both the measurement and the calculation of the surface astigmatism permits an objective judgement of the quality of vision through progressive power lenses and so also provides a basis for comparative tests.

Prescription

Since the power of the distance portion of Progressiv R is so well stabilised, there is no power effect for the wearer, even for a large viewing angle. This means that the lens power can be ordered exactly to prescription with no need of any modification.

Similarly, because of the good stabilisation of the near portion power, the addition obtained during refraction requires no modification.

Characteristic dimensions and markings

Fig 6 shows the characteristic markings which assist in the fitting and checking. The main meridian, as a flat curve, connects the edge groove, the lens centre and the near reference point. The nasal rotation of the near portion through 8° means a nasal decentration of 2mm—which corresponds to an average working distance of 40mm. The lens is engraved in this rotated position and the red markings are applied to indicate the reference. The distance power is checked at the distance reference point B_F, 6mm above the geometric lens centre. The near power is checked at the near reference point B_N which is 14mm below G and 2mm inwards. The centering cross, 2mm above the lens centre, serves as a reference point for the fitting. A prescribed prism is checked at the geometric centre G, but it must not be forgotten that all lenses have a thickness reduction prism (base down). The total prismatic value will always be found on the lens envelope. Even in cases of anisometropia there are no complications as the power of the thickness reduction prism is dependent only on the near addition.

With the aid of the permanent micro-engraving and the use of the characteristic dimensions the reference points can easily be restored. The middle point between the two circles at a distance of 34mm defines the geometrical lens centre, and the line connecting the centres of the two circles is the horizontal lens axis. To distinguish between the left and the right lens, the addition is always engraved under the temporal circle and the Rodenstock trademark R under the nasal circle.

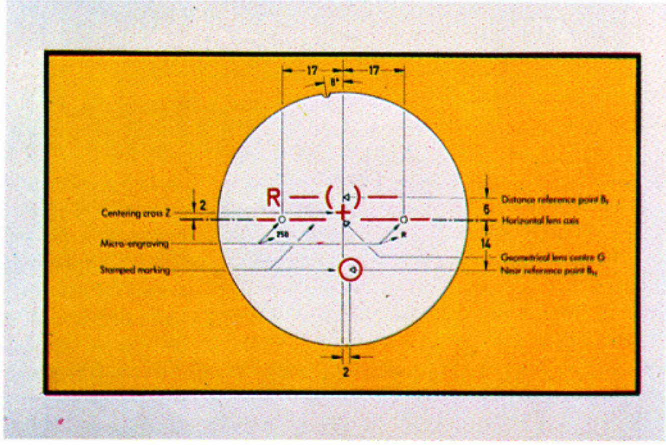


Fig 6: Characteristic markings and dimensions of Progressiv R

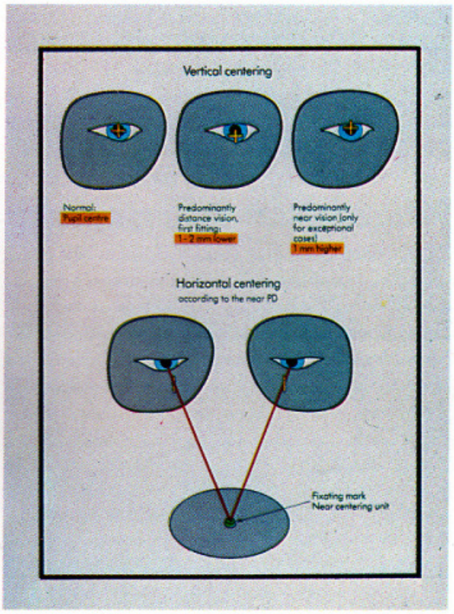


Fig 7: Recommended centering for Progressiv R. *Top:* The yellow cross shows the nominal position of the centering cross stamped on the lenses. *Bottom:* The yellow markings show the lateral position of fixation lines in the plane of the spectacle frame for near vision

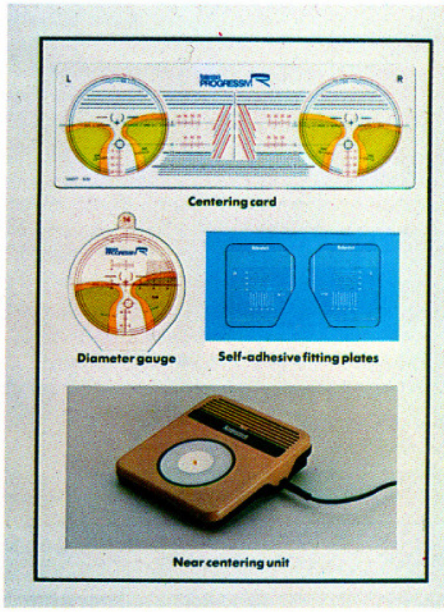


Fig 8: Fitting aids for Progressiv R *Top:* Centering card for fitting according to the distance PD, for checking for sufficient diameter and for restoration of the reference points. *Middle left:* Diameter gauge for the checking for sufficient diameter and for the restoration of the reference points. *Middle right:* Transparent self-adhesive centering plates. *Bottom:* Near centering unit for determining the near vision points according to the 'mirror-method'

Centering

As with all progressive lenses, precise centering is also of great importance for Progressiv R. In order to retain an optimum coincidence of the monocular vision fields for near and intermediate distances (see Fig 7), the horizontal position should best be taken according to the near PD. Nevertheless, in uncritical cases the centering can be undertaken according to the distance PD since both the progression corridor and the near portion possess sufficient width. However, should the eyes clearly converge asymmetrically, for example if one eye is dominant, then centering must be done according to the near PD.

Prescribed prisms alter the course of the fixation lines and displace the section points in the spectacle plane relative to the fitting situation without a prism. To compensate for this effect, the prismatic progressive lens must—in relation to normal centering—be decentred by 0.25mm for every horizontal prism component of 1 prism dioptre. This decentration is made inwards for prism base-out and outwards for prism base-in.

For a vertical fitting it is normal to proceed with the centering cross at the height of the pupil centre when the patient is looking straight ahead (Fig 7). With lenses for predominantly distance vision and also for cases of a first fitting, a lens positioning 1 to 2mm lower than normal can be recommended. Only in those rare cases where Progressiv R will be used almost exclusively for near vision should the lens position be 1mm higher than normal.

Subjective comparison tests

Test programme and preparation

To the purely technical specifications of the optical properties and the design of Progressiv R we would now like to add the experiences of trial tests with the new lens. A comprehensive test programme had already been devised in the development phase of the lens. There were two main problems which had to be solved: the test and its evaluation had to be such as to ensure that firstly, a completely unprejudiced judgement of the lens would result. And secondly, the test questions had to be formulated in such a way that a comprehensive amount of information on the lens performance in practice would be obtained.

More than 100 spectacle wearers, none of whom had previously worn progressive lenses, took part in the tests. They were selected according to the statistical distribution of the near addition powers. Care was also taken with respect to the distance powers so that there was no significant deviation from the normal distribution for distance prescriptions. After the different spectacles had been worn alternately for an average of eight weeks, the questioning took place and subsequent to this a statistical evaluation of the results.

Results

In the overall judgement of the lens performance as expressed in a five-grade system with the marks 1 = very good . . . 5 = poor, the average mark for Progressiv R was 2.1—a result matched by no other test lens.

This aside, the following qualitative comments should also be mentioned: when judging the visual acuity for large angles of view in the distance portion, the spectacle wearers commented that they particularly noticed the aberration-free temporal part of Progressiv R and found it advantageous. The near portion was graded as wide to satisfactorily wide, although the test persons had previously only worn single vision, bifocal or trifocal lenses. Judgement for the intermediate portion was 'sufficiently wide' which, under the circumstances described above, is a remarkably good result. Distortion and image swim were found to be very slight, even with the high addition of 3.0D.

All in all we can say that in respect of the lens performance, Progressiv R can be regarded as good and—with a few exceptions—it is preferred to the single vision or multifocal lens previously worn.

Progressiv R fitting system

To ensure that Progressiv R is worn with optimum results, we have developed a multi-component fitting system as shown in Fig 8: it contains a near centering unit for the quick and accurate determining of the position of the near portion, a centering card, a diameter gauge and self-adhesive fitting plates.

Near centering unit

The measuring principle is based on the 'mirror method' for determining the location of the near vision points in the spectacle plane. A luminous ring, the centre of which is fixated, produces a corneal reflex image with which the centre of reading can be ascertained quickly and accurately. The unit is generally suitable for fitting multifocal lenses, but at the same time, it is especially to be recommended for progressive lenses because in their case good results can only be obtained with a careful and accurate fitting.

Centering card

If the fitting is done with reference to the distance PD, the separately obtained monocular PD can, with the aid of the centering card, be readily transferred to the marking aid on or in the frame and thus, the horizontal position of the centering cross be fixed. It is also possible to check whether the diameter of the uncut lens is sufficient for the selected frame, and whether the near portion is being properly used. For this purpose—as on the diameter gauge—the lens areas suffering from aberrations are coloured. Finally, the centering card also serves as an aid for the restoring of the reference points onto the lens.

Diameter gauge

As with all other Rodenstock spectacle lenses, there is also a special diameter gauge for Progressiv R for the checking of the glazing capability and the size of the reading portion in use. It also shows the stamped markings and the micro-engraving for the restoration of the reference points.

Centering plates

For marking the position of the centering cross in the spectacle plane, spring-in plastic plates have proved to be of great value. The shaping of the plate is, however, a li[illegible] wearisome, as the appropriate former is always required for this purpose. Some improvement is offered by the new self-adhesive fitting plates. With the aid of the printed reference lines they are aligned to the eye-shape of the frame and simply pressed on. This simplifies the fitting process appreciably.

Conclusion

The new surface design of Progressiv R has proved its superiority in comparative wearing tests. Thus, this lens extends the possibilities for taking care of presbyopic eyes and enriches the choice of progressive lenses. The care which must be taken in the fitting of such lenses is also necessary with Progressiv R. There is, however, no need for any special measures to be taken, or for any special rules to be observed, either during refraction or when ordering.

Bibliography

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