No-Strain Reading Glasses

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Abstract: *Reading glasses with prisms to make the light rays from a nearby source enter the eyes straight on instead of at an angle, as if they had come from a distance, will allow the wearer to read without having either to accommodate or converge the eyes. This feature would be especially useful for people with presbyopia or uveitis or both, but would make for a more relaxed reading experience for anyone.*

When a person looks at a nearby object, they have to make two adjustments to their eyes. They must converge their eyes so that both eyes look at the same point in space. They must also thicken the lenses of their eyes so that the light rays coming from the source, which are diverging, will be focussed by the lens of each eye on the retina instead of behind it, a process called accommodation. Convergence is accomplished by contracting the medial rectus muscle of both eyes [1]. Accommodation is accomplished by contracting the ciliary muscles, allowing the lens to thicken [2] – if it is flexible enough.

These two processes are not independent. When the person converges their eyes, the ciliary muscles automatically contract [2]. Each of these processes causes some strain on the eyes, especially for someone with uveitis in one or both eyes. For someone with presbyopia, which is condition, usually age-related, in which the lenses of the eyes are no longer flexible enough to thicken, accommodation is not possible, making it especially advantageous to avoid the necessity of convergence.

The solution I propose to this problem is to add to the prescription for reading glasses a prism, with the base adjacent to the nose, that deflects the diverging light rays from a nearby source so that they enter the eyes straight on instead of at an angle, as if they had come from a distance, thus making convergence unnecessary, while the rest of the prescription also makes accommodation unnecessary. In this way, the wearer can read without contracting any of their eye muscles.

How strong should the prisms be? This depends on how far from their face the person holds their reading material and how far apart their eyes are. Optometrists measure prism strength in diopters, and a prism diopter is defined as the strength of a prism that deflects a light ray from 1 meter away by 1 centimeter [3]. We trace the path of a light ray backwards from the pupil of the eye to the reading material, assuming that it emerges from the pupil straight on and has to be deflected by the prism so that reaches the source exactly opposite the midpoint between the two pupils. It must be deflected by half the distance between the two pupils over the distance between the prism and the reading material. This indicates that the number of diopters that each prism should be is half the distance between the pupils divided by the distance between the prisms and the reading material and multiplied by 100. The average distance for reading is about 25 centimeters, which would indicate a prescription of +4 diopters for someone with normal eyes, and the average distance between the pupils is about 6 centimeters. In this average case, a prism of 12 diopters would seem to be of the correct strength.

Of course, rather than relying on the formula, the right strength must be tested experimentally for the prospective wearer before any lenses are ground, because the prisms will give the person double vision when they are looking at an object farther away than the distance for which the prisms were chosen.

REFERENCES

[1] https://en.wikipedia.org/wiki/Vergence

[2] https://en.wikipedia.org/wiki/Accommodation_(eye)

[3] https://medical-dictionary.thefreedictionary.com/prism+dioptre