

ORIGINAL ARTICLE

Many Ready-Made Reading Spectacles Fail the Required Standards

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ABSTRACT

Purpose. To determine whether the optical quality of near-vision ready-made spectacles (RMS) reaches the quality assurance levels required by the international standard ISO 16034:2002.

Methods. A total of 322 near-vision RMS of powers +2.50, +3.00, and +3.50 DS were randomly selected from high street stores in North East England. Assessments of the optical quality of the RMS were made, and the results were compared against the standards included in ISO 16034:2002 and the more lenient standards used to assess RMS in low-resource countries.

Results. Forty-eight percent of the 322 near-vision RMS failed to provide the optical quality required by international standards, with 62% of the +3.50 DS spectacles failing the requirements. This was principally due to a high prevalence of induced horizontal (60%) and vertical prism (32%) beyond the tolerance levels stipulated in ISO 16034:2002. The figures were similar when the more lenient standards used to assess RMS in low-resource countries were used due to RMS centration distances that were too large.

Conclusions. There is a large prevalence of significant amounts of induced horizontal and vertical prism in higher powered near-vision RMS such as +3.50 DS. Given that the need for high-powered RMS indicates the presence of hyperopia and/or age-related eye disease in addition to presbyopia, it may be appropriate to restrict the sale of RMS to optical powers of +1.00 to +2.50 DS, which would contain much fewer errors. We also strongly recommend that manufacturers use a centration distance for near-vision RMS that is similar to an average near (and not distance) interpupillary distance.

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Key Words: ready-made reading spectacles, over-the-counter glasses, presbyopia, induced prism, near interpupillary distance

Ready-made spectacles (RMS) for near work are available in most high-resource countries from supermarkets and similar stores for the correction of presbyopia, defined as “a refractive condition in which the accommodative ability of the eye is insufficient for near work, due to ageing.”¹ To date, there has been no evaluation of whether they meet required optical standards. Provision of RMS for both distance and near in low-resource countries provides glasses of equal binocular spherical power and a fixed centration distance (CD), but the eye care programs that provided these RMS have reported including a quality assurance system that checks the CD and limits induced prism and errors in dioptric powers, in addition to checking for lens scratches and waves, bevel defects, lens mounting, frame construction and

finish, etc.²⁻⁴ The quality assurance provided for near-vision RMS in developed countries is limited to any manufacturers’ claim to conformity to quality assurance standards. Customers are expected to check for themselves that they fit comfortably and that they can see with them before purchase.

In this study, we examined more than 300 high-powered (+2.50 to +3.50 DS) RMS designed for near work purchased from a range of U.K. high street shops and assessed them for conformity to the international standard ISO 16034:2002 (Ophthalmic optics—Specifications for single-vision ready-to-wear near-vision spectacles) which requires the same optical standards as the British and European Standard BS EN 14139 (2002, 2010). ISO 16034:2002 has not been adopted by the United States, which is currently developing its own standard. We also assessed the near-vision RMS against the optical tolerances suggested for RMS in low-resource countries.² From these results, we make recommendations of how to improve the quality of RMS sold in high-resource countries.

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METHODS

Near-vision RMS covered by the international standard ISO 16034:2002 must consist of two single-vision spherical lenses of the same power (between +1.00 to +3.50 DS) and they are typically sold in +0.50 steps. Previous evaluations of RMS used in low-resource countries found a much larger prevalence of problems, particularly in terms of induced prism, for high-powered spectacles compared with low-powered RMS^{2,5} and this would be expected. Induced prism is caused when the optical centers of the lenses are either vertically misaligned (causing vertical-induced prism) or do not match the wearer's inter-pupillary distance (PD) (causing horizontal-induced prism). The amount is defined by Prentice's Rule, where induced prism = power of glasses in diopters \times centration discrepancy in centimeters. Higher powered spectacles are therefore more likely to contain induced prism, and for this reason, only the higher powered ready-readers of +2.50, +3.00, and +3.50 DS were assessed in this study. A total of 322 near-vision RMS with these powers were randomly selected from high street stores in North East England that have stores throughout the United Kingdom and included discount stores, major supermarkets and department stores, large optical retail stores, and several smaller independent stores. Assessments of the RMS were made by a registered optometrist (D.E.) and dispensing optician (A.G.) using lensmeters and a frame rule, with 10% of all spectacles assessed by both to ensure conformity. The spectacles were assessed against the standards included in ISO 16034:2002, which many assessed spectacles claimed conformity to.^a These are as follows:

- Optical tolerances: The specified tolerance is that the back vertex power must be within 0.12 D of the manufacturer's specifications and with no cylindrical power above 0.09 D (from ISO 8980-1).
- Prism tolerances were 0.33 prism diopters vertically and horizontally. Horizontal prism is dependent on the difference between the horizontal optical centers of the RMS and the patient's PD when reading. To determine whether the glasses were within the prism tolerances listed in ISO 16034:2002, horizontal optical centers were compared with the CD specified on the frame if available (as required by ISO 16034:2002 but not always provided). When CDs were not provided on the frame, a target CD of 62 mm was used as this was the most commonly used CD on the assessed RMS (174 provided a CD and 128 or 74% were 62 mm).

Ramke et al.² suggested a range of standards for RMS to be used in low-resource countries for both distance and near tasks. These standards recognize that mass-produced RMS will include some defects that would not be tolerated in custom-made spectacles but will be sufficiently rigorous to afford customer satisfaction and protection. These included tolerances for dioptric power of up to 0.25 DS and 0.25 DC and induced prism of up to 1 prism diopter horizontally and 0.5 prism diopter vertically. These standards were also used to assess the 322 near-vision RMS in this study. The amount of induced horizontal prism was determined using an average value for the near PD of 200 adults that were collated from the records of the University of Bradford Eye Clinic.

^aThey claimed conformity to the British and European standard BS EN 14139:2002 or 2010, but this standard requires the same optical standards as ISO 16034:2002.

RESULTS

Of the 322 near-vision RMS, 113 were of named power +2.50 DS (35%), 116 were +3.00 DS (36%), and 93 were +3.50 DS (29%). The slightly lower number of +3.50 DS spectacles is because some stores only sold ranges up to +3.00 DS. The majority of lenses were low cost between £1 to 2 or about \$1.6 to 3.2 (48%) or £3 to 5 or \$4.8 to 8.0 (19%) but included spectacles in the midrange of £6 to 12 or \$9.6 to 19.2 (13%) and higher range of £13 up to £32 or \$20.8 to 51.2 (19%). Forty-four percent were marked on the frame and/or tag to indicate conformity to BS EN 14139:2002 or BS EN 14139:2010 (and thus conformity to ISO 16034:2002), 40% were CE (European conformity) marked and indirectly indicated conformity to those standards, and 16% were not marked.

The percentage of RMS not conforming to the optical tolerances stated in ISO 16034:2002 are shown in Table 1 for each of the three powers. Errors were found in 30% of those marked claiming conformity to the standards, 68% of those marked with the CE mark and indirectly claiming conformity to the standards, and 58% of those with no markings.

The percentages of RMS not conforming to the optical tolerances typically used in low-resource countries² are shown in Table 2 for each of the three powers. To calculate horizontal prism, a near PD of 60 mm was used, based on the collated results from the University of Bradford eye clinic. The average distance and near PDs of 100 white presbyopic males (mean \pm 1 SD age, 58.7 \pm 15.0 years) taken randomly from the records of the eye clinic were 64.5 \pm 3.4 mm and 60.6 \pm 3.5 mm, respectively. The average distance and near PDs of 100 white presbyopic females (mean \pm 1 SD age, 56.7 \pm 13.8 years) were 61.6 \pm 2.7 mm and 58.1 \pm 2.6 mm, respectively. Average distance and near PDs for all patients combined were 63.0 \pm 3.4 mm and 59.4 \pm 3.3 mm, respectively.

DISCUSSION

Despite 84% of the 322 high-powered RMS assessed claiming conformity directly or indirectly (via the CE mark) to the standard ISO 16034:2002, 48% failed the optical standards required (Table 1). This was particularly the case for the higher powered spectacles, with 62% of the +3.50 DS RMS failing to reach the required

TABLE 1. Percentages of ready-made reading spectacles of power +2.50 DS (N = 113), +3.00 DS (N = 116), and +3.50 DS (N = 93) that were found to be outside tolerance levels for power and induced prism as stipulated by the International Standard ISO 16034:2002

	Outside tolerances			
	Power (%)	Vertical prism (%)	Horizontal prism (%)	All optical measures (%)
+2.50	7	13	34	40
+3.00	10	20	33	46
+3.50	10	32	60	62
All	9	21	42	48

TABLE 2.

Percentages of ready-made reading spectacles of power +2.50 DS (N = 113), +3.00 DS (N = 116), and +3.50 DS (N = 93) that were found to be outside tolerance levels used for ready-made spectacles provided in low-resource countries² using an average near interpupillary distance of 60 mm

Power (%)	Outside tolerances		
	Vertical prism (%)	Horizontal prism (%)	All optical measures (%)
+2.50	1	24	27
+3.00	5	38	40
+3.50	6	69	70
All	4	42	52

optical standards compared with 40% of the +2.50 DS RMS. This was due to a large prevalence of induced horizontal and vertical prism above ISO 16034:2002 tolerance levels in the higher powered glasses. Significant induced horizontal prism was found in 34% of the +2.50 DS RMS but in 60% of the +3.50 DS RMS, and significant induced vertical prism was found in 13% of the +2.50 DS RMS but in 32% of the +3.50 DS RMS (Table 1). Errors in dioptric power were the same for all three powers of RMS at about 10%. Although the marking of a frame or tag indicating conformity to BS EN 14139 (i.e., ISO 16034:2002) standards suggested better conformity to those standards with only 30% outside the tolerance levels, the CE mark provided little or no quality assurance with 68% being outside the tolerance levels, which was greater than those RMS without markings (58%). Price provided some indication of quality in that the cheapest near-vision RMS costing less than about \$4 included 65% that did not reach the ISO standard tolerance levels and the cheapest RMS seem best avoided. However, price was not a perfect indicator of quality in that a relatively small percentage of RMS in the \$5 to 8 price bracket included errors (28%), and errors were higher in the higher priced RMS of between \$10 and \$50 (about 42%). This variation in error rates appeared to be manufacturer dependent.

Using the standards for RMS in low-resource countries,^{2,5} virtually all +2.50 DS RMS were within optical tolerance levels for power and induced vertical prism (Table 2). The relatively poor pass rate of 76% for horizontal prism despite the more lenient tolerance level stated by Ramke et al.² was due to a high average CD of 63.7 ± 2.8 mm compared with the average near PD of 60 mm. The larger CD is partly due to the inappropriate use of CDs of 62 and 64 mm in 74 and 18%, respectively, of the 174 RMS that provide marked centration values as required by ISO 16034:2002. This suggests that manufacturers have erroneously taken the more commonly quoted distance PD as their guideline, yet near PDs are usually 3 to 5 mm smaller than the distance PD at about 61 mm for males and 58 mm for females.^{1,6} Clearly, manufacturers should aim to provide a CD appropriate for near work of about 60 mm, which they are not doing at the present time.

We used the CD marked on the RMS frames to calculate induced horizontal prism for the assessment of compliance to ISO

standards (or 62 mm if this was not provided as it was by far the most commonly marked value) as this seemed appropriate given that ISO require that a CD is provided for this reason. However, the average near PD value of 60 mm is a more appropriate figure to calculate the average induced horizontal prism, and if we had used this figure, even more near-vision RMS would have failed ISO-required tolerance levels for induced horizontal prism. The figures provided are therefore conservative.

The prevalence of induced vertical prism >0.50 prism diopters was found to be about 10% for the higher powered +3.00 and +3.50 DS RMS (Table 2). Ramke et al.² reported a very variable prevalence of vertical prism errors in batches of RMS from different suppliers, from 0.4 to 3.0% in some batches and 14 and 26% in others. Interestingly, they reported that huge improvements in induced vertical prism were gained after one supplier was given feedback, with induced vertical prism falling from 26% in an initial batch to 1% in a subsequent batch.

What Are the Possible Adverse Effects from RMS?

Possible adverse effects from incorrect RMS have not been documented but would presumably be similar to those from incorrect custom-made spectacles.⁷⁻⁹ Like custom-made reading spectacles,¹⁰ it also seems highly probable that some people will wear near-vision RMS for intermediate and distance tasks, including walking,¹¹ particularly as age-related hyperopia increases. Symptoms that could be due to incorrect spherical correction of presbyopia and prismatic effects in custom-made spectacles are presented in Table 3. From this perspective, the similar satisfaction rates reported for ready-made and custom-made spectacles in studies in low-resource countries^{3,4} are not relevant given the better quality assurance provided for the RMS in those studies (the same as given to custom-made spectacles) and because participants were children and young adults and the ability to adapt to induced prism^{12,13} and refractive changes¹⁴ get progressively worse with age. The prevalence of patients returning to optometric practice dissatisfied with their custom-made spectacles is about 1.5 to 2%^{8,9} with the great majority of these patients being presbyopic (88%),⁹ indicating the greater adaptation problems for older patients.^{9,14} We suggest that adverse effects with RMS will be similar to those in Table 3 but with a higher prevalence than 1.5 to 2%. It also seems likely that higher powered RMS that contain the most errors (Tables 1 and 2) will have the highest prevalence of adverse effects. It has been suggested that abnormalities of vergence, such as can be provided by induced prism, can lead to inappropriate vestibulo-ocular reflex adjustments and thereby poor gaze stabilization, dizziness, and vertigo.^{15,16} Through a similar mechanism, vertical heterophorias of even small amounts <1 prism diopter have been shown to decrease postural stability.^{17,18} However, the impact of induced horizontal prism in particular is not known and base-in prism in particular may provide some convergence relief at near and be well tolerated. It is therefore unfortunate that the majority of the induced prism was base-out (an average CD of 63.7 compared with the average near PD of 60 mm) and could increase any convergence problems.

TABLE 3.

Transient or persistent adverse effects of spherical single vision, custom-made spectacles

Symptom type	Presenting symptom or adverse effect	Possible etiology
Referred	Headaches and asthenopia referred to ocular adnexa Mild vertigo or dizziness	<ul style="list-style-type: none"> • High presbyopic additions • Faulty lens centration • Decompensated heterophoria • New prismatic correction • Relative prismatic effects
Disorders of visual perception and binocular vision	Micropsia Macropsia Blurred vision Diplopia	<ul style="list-style-type: none"> • Base out prisms • Recent presbyopic additions • Base in prisms • Incorrect effective power • Inappropriate vocational use • Residual uncorrected errors • Faulty lens centration

Adapted with permission from *Optician* 174, 9–12, 1977.

Higher Powered Reading Spectacles and the Link with Eye Disease

It is clear that the higher powered near-vision RMS contain the most optical errors (Tables 1 and 2) and are likely to lead to the most adverse effects. Perhaps surprisingly, research indicates that these high powers do not solely correct presbyopia and are often indicative of visual acuity losses due to age-related eye diseases. Presbyopia has been described as a maverick of ageing in that it results from growth of the ocular lens and a combination of factors which are not all governed by senescence and fails to fit into the general picture of ageing of other tissues.¹⁹ Indeed, objective measurements show that accommodative power reaches zero at the age of about 58 years,²⁰ which is therefore when presbyopic progression ends. Subjective measurements of “accommodation” above this age do not reveal real focusing power but are produced by depth of focus, which increases due to age-related reductions in pupil size.²¹ The mean reading addition power does increase after the age of 60 years, but at a much slower rate so that the change in reading add power with age is bilinear.^{22–25} Fig. 1 shows reading addition data from 615 presbyopic white patients taken consecutively from the records of the University of Bradford Eye Clinic and shows a bilinear plot of add vs. age with the change occurring at the age of 54.1 years. The curve-fitting capabilities of graph-making software (KaleidaGraph ver. 3.08; Synergy Software, Reading, PA) were used to perform the least-squares bilinear curve fit to the data. The slower increase in power after the age of 55 to 60 years is due to a decrease in working distance used by older people, mainly to counteract reduced visual acuity caused by age-related eye diseases.^{26,27} The closer working distance provides extra magnification of the text but requires a higher powered lens to focus at this closer distance. Some wearers of +3.00 or +3.50 DS RMS could have hyperopia (of +1.00 or +1.50 DS) and presbyopia (of +2.00 DS), but others will have visual acuity loss due to age-related eye disease. At the age of 55 years, the power of reading glasses needed to correct presbyopia is about +2.00 DS (Fig. 1),^{22–25} with a range from about +1.50 to +2.50 DS depending on the patient’s preferred working distance.

Study Limitations

The high prevalence of errors in the sample of about 50% may be due to an overrepresentation of the cheapest RMS. We are not aware of any data indicating the percentage of ready readers bought at different stores and within different price brackets, so a representative sample could not be sought from that perspective. We also did not take a similar number from each store and price bracket (by using computer randomization for example) but left this to four individual purchasers and may have led to an overrepresentation from the discount stores. However, it could be argued that people buying ready readers will take a similar view. The high representation of ready readers from discount stores may also be representative of their prevalence in North East England and this may be different in other areas of the United Kingdom and other countries.

CONCLUSIONS

Despite 84% of the 322 RMS assessed claiming conformity directly or indirectly (via the CE mark) to the British and European standard BS EN 14139 (and thus the international standard ISO 16034:2002), nearly one-half failed to reach appropriate quality assurance levels and 62% of the +3.50 DS RMS were outside the required tolerance levels. The CE mark provided little or no quality assurance with 68% being outside the tolerance levels, which was more than those glasses without markings. Using the standards used for RMS in low-resource countries,^{2,5} virtually all glasses of +2.50 DS power are within optical tolerance levels for power and induced vertical prism. A failure rate of 27% for horizontal prism was due to inappropriately high CDs being used, which seem to be based on a typical distance PD rather than a near PD, which is 3 to 5 mm smaller. We strongly recommend that manufacturers use a CD value equal to an average near PD at about 60 mm for near-vision RMS.

There is a large prevalence of significant amounts of induced horizontal and vertical prism in the higher powered RMS such as +3.50 DS (60 and 32%, respectively, according to ISO 16034:

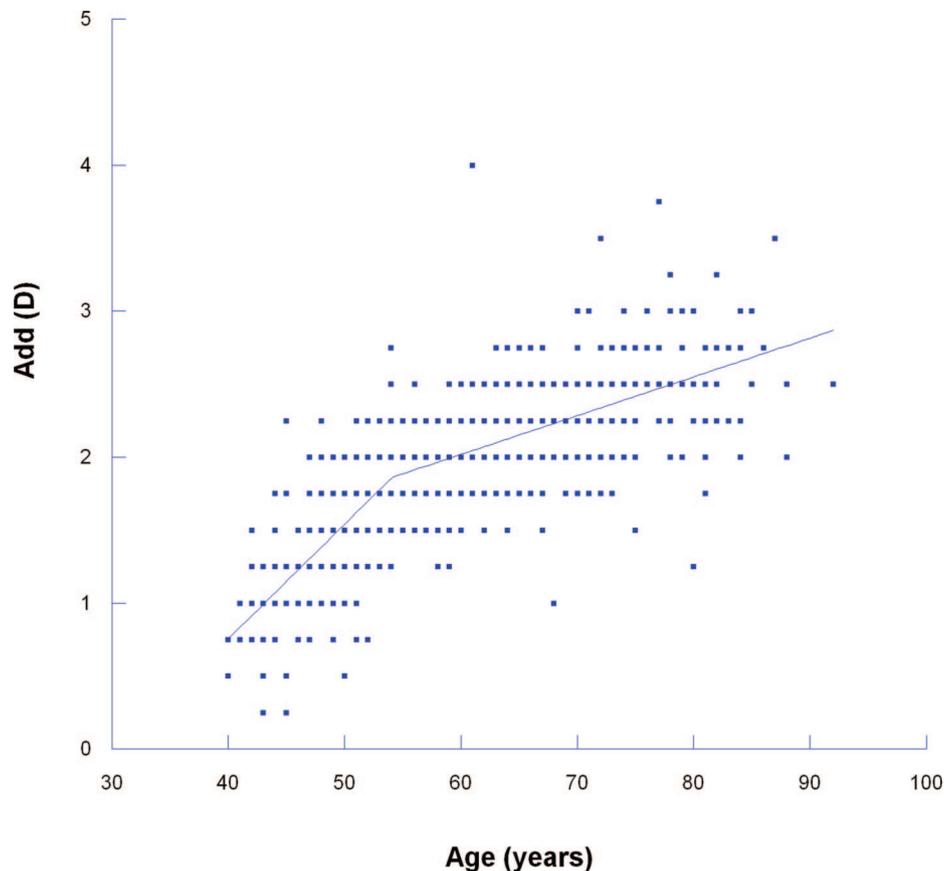


FIGURE 1.

Data of reading addition as a function of age from the record cards of 615 presbyopic white patients at the University of Bradford Eye Clinic. A least-squares bilinear curve was fitted to the data ($r = 0.80$), with the reduction in the change in reading addition with age occurring at 54 years. A color version of this figure is available online at www.optvissci.com.

2002; 69 and 11%, respectively, according to the tolerance levels stated by Ramke et al.²; Tables 1 and 2). This would likely be improved by monitoring the products and providing manufacturers with feedback and would certainly be improved if manufacturers produced RMS that satisfied ISO 16034 requirements. An alternative approach given that the need for high-powered RMS for near work indicates the presence of hyperopia and/or age-related eye disease^{26,27} in addition to presbyopia would be to simply ban their sale and restrict the sale of near-vision RMS to optical powers of +1.00 to +2.50 DS, which would contain much fewer errors. Given an available range of +1.00 to +4.00 DS, only 19% of RMS provided in a low-resource country for presbyopia were +3.00, +3.50, or +4.00 DS.²⁸ In this regard, it may be pertinent that some UK stores already have RMS ranges that only extend to +3.00 DS and over-the-counter reading spectacles sales are limited to powers not exceeding +2.50 (Rhode Island) and +2.75 DS (New York).²⁹

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REFERENCES

1. Millodot M. Dictionary of Optometry and Visual Science, 7th ed. Edinburgh: Elsevier; 2009.
2. Ramke J, Palagyi A, Toit R, Brian G. Applying standards to ready-made spectacles used in low-resource countries. *Optom Vis Sci* 2009; 86:1104–11.
3. Zeng Y, Keay L, He M, Mai J, Munoz B, Brady C, Friedman DS. A randomized, clinical trial evaluating ready-made and custom spectacles delivered via a school-based screening program in China. *Ophthalmology* 2009;116:1839–45.
4. Keay L, Gandhi M, Brady C, Ali FS, Mathur U, Munoz B, Friedman DS. A randomized clinical trial to evaluate ready-made spectacles in an adult population in India. *Int J Epidemiol* 2010;39:877–88.
5. du Toit R, Ramke J, Brian G. Tolerance to prism induced by ready-made spectacles: setting and using a standard. *Optom Vis Sci* 2007; 84:1053–9.
6. Elliott DB. Determination of the refractive correction. In: Elliott DB, ed. *Clinical Procedures in Primary Eye Care*, 3rd ed. Edinburgh: Elsevier/Butterworth Heinemann; 2007:83–150.
7. Ball GV. Non-tolerance to optical prescriptions. *Optician* 1977;174: 9–12.
8. Hrynchak P. Prescribing spectacles: reasons for failure of spectacle lens acceptance. *Ophthalmic Physiol Opt* 2006;26:111–5.
9. Freeman CE, Evans BJ. Investigation of the causes of non-tolerance to optometric prescriptions for spectacles. *Ophthalmic Physiol Opt* 2010;30:1–11.

10. McGarry MB, Manning TM. The effects of wearing corrective lenses for presbyopia on distance vision. *Ophthalmic Physiol Opt* 2003;23:13–20.
11. Davies JC, Kemp GJ, Stevens G, Frostick SP, Manning DP. Bifocal/varifocal spectacles, lighting and missed-step accidents. *Safety Sci* 2001;38:211–26.
12. Winn B, Gilmartin B, Sculfor DL, Bamford JC. Vergence adaptation and senescence. *Optom Vis Sci* 1994;71:797–800.
13. Kono R, Hasebe S, Ohtsuki H, Furuse T, Tanaka T. Characteristics and variability of vertical phoria adaptation in normal adults. *Jpn J Ophthalmol* 1998;42:363–7.
14. Press LJ, Werner DL. *Clinical Pearls in Refractive Care*. Boston: Butterworth-Heinemann; 2002.
15. Anoh-Tanon MJ, Bremond-Gignac D, Wiener-Vacher SR. Vertigo is an underestimated symptom of ocular disorders: dizzy children do not always need MRI. *Pediatr Neurol* 2000;23:49–53.
16. Bucci MP, Le TT, Wiener-Vacher S, Bremond-Gignac D, Bouet A, Kapoula Z. Poor postural stability in children with vertigo and vergence abnormalities. *Invest Ophthalmol Vis Sci* 2009;50:4678–84.
17. Matheron E, Kapoula Z. Vertical phoria and postural control in upright stance in healthy young subjects. *Clin Neurophysiol* 2008;119:2314–20.
18. Matheron E, Kapoula Z. Vertical heterophoria and postural control in nonspecific chronic low back pain. *PLoS One* 2011;6:e18110.
19. Pierscionek BK, Weale RA. Presbyopia—a maverick of human aging. *Arch Gerontol Geriatr* 1995;20:229–40.
20. Charman WN. The path to presbyopia: straight or crooked? *Ophthalmic Physiol Opt* 1989;9:424–30.
21. Wang B, Ciuffreda KJ. Depth-of-focus of the human eye: theory and clinical implications. *Surv Ophthalmol* 2006;51:75–85.
22. Pointer JS. The presbyopic add. I. Magnitude and distribution in a historical context. *Ophthalmic Physiol Opt* 1995;15:235–40.
23. Pointer JS. The presbyopic add. II. Age-related trend and a gender difference. *Ophthalmic Physiol Opt* 1995;15:241–8.
24. Pointer JS. The presbyopic add. III. Influence of the distance refractive type. *Ophthalmic Physiol Opt* 1995;15:249–53.
25. Blystone PA. Relationship between age and presbyopic addition using a sample of 3,645 examinations from a single private practice. *J Am Optom Assoc* 1999;70:505–8.
26. Millodot M, Millodot S. Presbyopia correction and the accommodation in reserve. *Ophthalmic Physiol Opt* 1989;9:126–32.
27. MacMillan ES, Elliott DB, Patel B, Cox M. Loss of visual acuity is the main reason why reading addition increases after the age of sixty. *Optom Vis Sci* 2001;78:381–5.
28. Vincent JE. Simple spectacles for adult refugees on the Thailand-Burma border. *Optom Vis Sci* 2006;83:803–10.
29. van Arnem R, Frederick KL. The regulation of sunglasses and reading glasses. *The Vision Council Regulations Manual*. May 2011, pp. 1–13. Available at: http://www.thevisioncouncil.org/members/media/Meetings/VCSR_RegulationsManual52011sds%20updated.pdf. Accessed September 20, 2011.

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