



Electronic books as low vision aids

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the radially orientated anterior ciliary vessels—an external landmark known to lie just posterior to the pars plicata.⁵ In the absence of trans-illumination facilities, injection just posterior to the inflection of the anterior ciliary vessels is suggested.

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Electronic books as low vision aids

Every year, around 34 000 people in England and Wales are newly registered as sight impaired or severely sight impaired, the majority of whom have some residual vision.¹ In order to read books, people with low vision will generally rely on large print books and supplementary optical² or electronic³ magnifiers. Only about 1.5% of the approximately two million books currently in print are available in large print format.⁴

Recently, several electronic book readers have become commercially available.⁵ These consist of a low glare electronic paper screen and internal memory, which can typically hold the full text of between 150 and 2000 full-length novels. Electronic paper has a wide viewing angle of almost 180° but a slow

Table 1 Parameters of some commonly available electronic books

Device	Diagonal screen size (cm)	Number of grey-scale levels	Dimensions (cm)	Weight (g)
Amazon Kindle	15.2	4	19×13.5×1.7	292
Amazon Kindle 2*	15.2	16	20.5×13.5×1	289
Amazon Kindle DX	25	16	26.5×18.5×1	535
Sony Reader PRS-505*	15.2	8	17.5×12×1	260
Sony Reader Touch	15.2	8	17.5×12×1	286
Sony Reader Pocket	12.7	8	15.8×10.7×1	220

*Devices reviewed in this paper. Data from <http://www.amazon.com> and <http://www.sony.co.uk>.

refresh speed of about 250 ms.⁶ Amazon's Kindle device has 300 000 books available in electronic format, and 11 000 are available through Waterstones in the UK for the Sony Reader. Table 1 shows the parameters of these and other popular electronic books. Here, we explore the utility of these two electronic books for use by the visually impaired.

The Sony Reader (Model PRS-505, Sony Corporation, Tokyo, Japan) has a 15-cm diagonal electronic paper screen. While it has a zoom function, the maximum text size is equivalent to a print size of 0.7 logMAR (6/30; ~N20 at 40 cm). As an acuity reserve of at least two times is required to read fluently, this system would only be useful for people with near visual acuity of around 0.3 logMAR (6/9.5; ~N7 at 40 cm) or better. In a well-lit office, maximum and minimum screen luminance was 16 and 70 cd/m², respectively, giving a maximum screen Michelson contrast of 63%. Assuming a contrast reserve of 10:1 for fluent reading,⁷ this would make reading difficult for anyone with a contrast sensitivity value of 1.10 log units or less, approximately 3% of the older population.⁸

The Amazon Kindle (Kindle 2, Amazon Inc, Seattle, Washington, USA) is a second-generation electronic reader. It has a similar 15-cm diagonal electronic paper screen to the Sony Reader. It has six levels of zoom (unlike the three text sizes on the Sony Reader) but the same maximum text size of 0.7 logMAR. Its maximum Michelson contrast is similar, at 62%. It incorporates a text-to-speech option which can read text aloud at up to 200 words per minute, close to a "normal" reading speed. However, the current model does not incorporate audio menus, limiting its use by those with no form vision.

Although we assume that the relatively low screen contrast is a limitation of electronic paper technology, the absence of a large text size option is a significant omission by the manufacturers. Those who are likely to suffer from age-related eye disease in the next decade will be increasingly familiar with technology: the greatest increase in internet use in the UK in 2006 was among adults aged 55–64.⁹ The opportunity to have access to at least ten times as many books as are currently available in large print would be of benefit to the millions of people worldwide with visual impairment. Although some tech-

nological limitations of electronic paper exist and we appreciate that cosmetic and handling factors must be considered with any commercial product, we hope that in the next generation of these devices, manufacturers will take the needs of the visually impaired community into account.

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