

ROME 2019
ROLES OF OPTOMETRY AND OPTICS

**A RANDOMISED CONTROLLED TRIAL OF
LOW POWER PLUS LENSES FOR PRE-
PRESBYOPES WITH DIGITAL EYESTRAIN**

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1

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- This study was supported Hoya Holdings NV and Institute of Optometry.
- HOYA as funder had no role in data collection and analysis or preparation of the manuscript (submitted) or this presentation
- Role of the team:
 - Study design: Bruce Evans, Olga Prenat, Natalia Vlasak, Robert Yammouni
 - Data collection: Robert Yammouni
 - Data analysis: Robert Yammouni, Bruce Evans
 - Presentation: Bruce Evans

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2

Plan

- Introduction
- Methods
- Results
- Conclusions

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3

Background

- Digital eyestrain (DES) = computer vision syndrome
 - Affects up to 40% of adults and 80% of teenagers
 - For reviews see Rosenfield (2016), Sheppard and Wolffsohn (2018)
 - Is DES a new problem or a rediscovery of an old problem (asthenopia)? Evans (2019)
 - Asthenopia can be classified as internal and external Sheedy et al. (2003)
 - The same classification applies to DES Gonzalez-Perez (2019)
 - Accommodative support lenses have been designed to ease DES, typically providing +0.50DS to +1.25DS.

Image courtesy of Dr Mariano Gonzalez-Perez & Hoya

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4

Research question & design

- Are low power plus lenses helpful in DES?
- Cross-sectional study with a double-masked randomised controlled crossover investigation of the immediate effect of plus lenses

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5

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6

Participants, inclusion & exclusion criteria

Inclusion & exclusion criteria

1. Aged between 16 and 40 years;
2. Significant symptoms on viewing digital devices, defined as a CVS-Q score of 6 or more;
3. Spend at least 6 hours a week viewing modern computerised displays (e.g., desktop, laptop, tablet, smart phone);
4. No ocular pathology requiring referral to an ophthalmologist;
5. No unexplained poor visual acuity (worse than 6/9);
6. No recent onset incomitancy or strabismus;
7. No history of refractive surgery.

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7

Test battery

Category	Test
Questionnaire	CVS-Q (validated DES/ CVS questionnaire) ²⁸ SANDZ (dry eye questionnaire) ²⁹
Ocular pathology	Direct and indirect ophthalmoscopy (dilation if required) & biomicroscopy
Dry eye assessment	Slit lamp biomicroscopy, DEWS grading ³⁰ and protocols for assessment
Refractive error	Non-cycloplegic retinoscopy & subjective refraction. For participants who habitually wear contact lenses, an over-refraction was performed.
Visual acuity (VA) ³¹	LogMAR on computerised LogMAR chart
Ocular motility	Pen torch in cardinal positions of gaze
Ocular alignment ³²	Cover test
Ocular alignment and vergence ³³	Cover test recovery, Mallett fixation disparity test, fusional reserves, dissociated phoria measurement, vergence facility, near point of convergence
Accommodation ³⁴	RAF rule ±1.50D flippers MEM retinoscopy

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8

Immediate effect of plus lenses

- Effect of plano (control), +0.50, +0.75, +1.25 **over full subjective Rx** at usual computer viewing distance, using Wilkins Rate of Reading Test (WRRT)
- The WRRT has been used to assess optometric interventions in
 - Visual stress
 - Head tilt
 - Prismatic corrections
 - Autism
 - Low refractive corrections
 - Dry eye
 - Low dose atropine
- Also asked about subjective preference

Wilkins et al. (1996) *Ophthalm. Physiol. Opt.* **16**: 491-497

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9

Dry eye grading – bespoke based on DEWS 1

Dry Eye Grading	1	2	3	4
1. Frequency of symptoms	At least once a week	At least once a month	At least once a month	At least once a month
2. Severity of symptoms	Mild	Moderate	Severe	Very severe
3. Frequency of irritation	At least once a week	At least once a month	At least once a month	At least once a month
4. Severity of irritation	Mild	Moderate	Severe	Very severe
5. Frequency of dryness	At least once a week	At least once a month	At least once a month	At least once a month
6. Severity of dryness	Mild	Moderate	Severe	Very severe
7. Frequency of redness	At least once a week	At least once a month	At least once a month	At least once a month
8. Severity of redness	Mild	Moderate	Severe	Very severe
9. Frequency of burning	At least once a week	At least once a month	At least once a month	At least once a month
10. Severity of burning	Mild	Moderate	Severe	Very severe
11. Frequency of itching	At least once a week	At least once a month	At least once a month	At least once a month
12. Severity of itching	Mild	Moderate	Severe	Very severe
13. Frequency of foreign body sensation	At least once a week	At least once a month	At least once a month	At least once a month
14. Severity of foreign body sensation	Mild	Moderate	Severe	Very severe
15. Frequency of tearing	At least once a week	At least once a month	At least once a month	At least once a month
16. Severity of tearing	Mild	Moderate	Severe	Very severe
17. Frequency of blurred vision	At least once a week	At least once a month	At least once a month	At least once a month
18. Severity of blurred vision	Mild	Moderate	Severe	Very severe
19. Frequency of halos	At least once a week	At least once a month	At least once a month	At least once a month
20. Severity of halos	Mild	Moderate	Severe	Very severe
21. Frequency of double vision	At least once a week	At least once a month	At least once a month	At least once a month
22. Severity of double vision	Mild	Moderate	Severe	Very severe
23. Frequency of eye pain	At least once a week	At least once a month	At least once a month	At least once a month
24. Severity of eye pain	Mild	Moderate	Severe	Very severe
25. Frequency of eye fatigue	At least once a week	At least once a month	At least once a month	At least once a month
26. Severity of eye fatigue	Mild	Moderate	Severe	Very severe
27. Frequency of eye discomfort	At least once a week	At least once a month	At least once a month	At least once a month
28. Severity of eye discomfort	Mild	Moderate	Severe	Very severe
29. Frequency of eye irritation	At least once a week	At least once a month	At least once a month	At least once a month
30. Severity of eye irritation	Mild	Moderate	Severe	Very severe
31. Frequency of eye redness	At least once a week	At least once a month	At least once a month	At least once a month
32. Severity of eye redness	Mild	Moderate	Severe	Very severe
33. Frequency of eye dryness	At least once a week	At least once a month	At least once a month	At least once a month
34. Severity of eye dryness	Mild	Moderate	Severe	Very severe
35. Frequency of eye burning	At least once a week	At least once a month	At least once a month	At least once a month
36. Severity of eye burning	Mild	Moderate	Severe	Very severe
37. Frequency of eye itching	At least once a week	At least once a month	At least once a month	At least once a month
38. Severity of eye itching	Mild	Moderate	Severe	Very severe
39. Frequency of eye foreign body sensation	At least once a week	At least once a month	At least once a month	At least once a month
40. Severity of eye foreign body sensation	Mild	Moderate	Severe	Very severe
41. Frequency of eye tearing	At least once a week	At least once a month	At least once a month	At least once a month
42. Severity of eye tearing	Mild	Moderate	Severe	Very severe
43. Frequency of eye blurred vision	At least once a week	At least once a month	At least once a month	At least once a month
44. Severity of eye blurred vision	Mild	Moderate	Severe	Very severe
45. Frequency of eye halos	At least once a week	At least once a month	At least once a month	At least once a month
46. Severity of eye halos	Mild	Moderate	Severe	Very severe
47. Frequency of eye double vision	At least once a week	At least once a month	At least once a month	At least once a month
48. Severity of eye double vision	Mild	Moderate	Severe	Very severe
49. Frequency of eye pain	At least once a week	At least once a month	At least once a month	At least once a month
50. Severity of eye pain	Mild	Moderate	Severe	Very severe
51. Frequency of eye fatigue	At least once a week	At least once a month	At least once a month	At least once a month
52. Severity of eye fatigue	Mild	Moderate	Severe	Very severe
53. Frequency of eye discomfort	At least once a week	At least once a month	At least once a month	At least once a month
54. Severity of eye discomfort	Mild	Moderate	Severe	Very severe
55. Frequency of eye irritation	At least once a week	At least once a month	At least once a month	At least once a month
56. Severity of eye irritation	Mild	Moderate	Severe	Very severe
57. Frequency of eye redness	At least once a week	At least once a month	At least once a month	At least once a month
58. Severity of eye redness	Mild	Moderate	Severe	Very severe
59. Frequency of eye dryness	At least once a week	At least once a month	At least once a month	At least once a month
60. Severity of eye dryness	Mild	Moderate	Severe	Very severe
61. Frequency of eye burning	At least once a week	At least once a month	At least once a month	At least once a month
62. Severity of eye burning	Mild	Moderate	Severe	Very severe
63. Frequency of eye itching	At least once a week	At least once a month	At least once a month	At least once a month
64. Severity of eye itching	Mild	Moderate	Severe	Very severe
65. Frequency of eye foreign body sensation	At least once a week	At least once a month	At least once a month	At least once a month
66. Severity of eye foreign body sensation	Mild	Moderate	Severe	Very severe
67. Frequency of eye tearing	At least once a week	At least once a month	At least once a month	At least once a month
68. Severity of eye tearing	Mild	Moderate	Severe	Very severe
69. Frequency of eye blurred vision	At least once a week	At least once a month	At least once a month	At least once a month
70. Severity of eye blurred vision	Mild	Moderate	Severe	Very severe
71. Frequency of eye halos	At least once a week	At least once a month	At least once a month	At least once a month
72. Severity of eye halos	Mild	Moderate	Severe	Very severe
73. Frequency of eye double vision	At least once a week	At least once a month	At least once a month	At least once a month
74. Severity of eye double vision	Mild	Moderate	Severe	Very severe
75. Frequency of eye pain	At least once a week	At least once a month	At least once a month	At least once a month
76. Severity of eye pain	Mild	Moderate	Severe	Very severe
77. Frequency of eye fatigue	At least once a week	At least once a month	At least once a month	At least once a month
78. Severity of eye fatigue	Mild	Moderate	Severe	Very severe
79. Frequency of eye discomfort	At least once a week	At least once a month	At least once a month	At least once a month
80. Severity of eye discomfort	Mild	Moderate	Severe	Very severe
81. Frequency of eye irritation	At least once a week	At least once a month	At least once a month	At least once a month
82. Severity of eye irritation	Mild	Moderate	Severe	Very severe
83. Frequency of eye redness	At least once a week	At least once a month	At least once a month	At least once a month
84. Severity of eye redness	Mild	Moderate	Severe	Very severe
85. Frequency of eye dryness	At least once a week	At least once a month	At least once a month	At least once a month
86. Severity of eye dryness	Mild	Moderate	Severe	Very severe
87. Frequency of eye burning	At least once a week	At least once a month	At least once a month	At least once a month
88. Severity of eye burning	Mild	Moderate	Severe	Very severe
89. Frequency of eye itching	At least once a week	At least once a month	At least once a month	At least once a month
90. Severity of eye itching	Mild	Moderate	Severe	Very severe
91. Frequency of eye foreign body sensation	At least once a week	At least once a month	At least once a month	At least once a month
92. Severity of eye foreign body sensation	Mild	Moderate	Severe	Very severe
93. Frequency of eye tearing	At least once a week	At least once a month	At least once a month	At least once a month
94. Severity of eye tearing	Mild	Moderate	Severe	Very severe
95. Frequency of eye blurred vision	At least once a week	At least once a month	At least once a month	At least once a month
96. Severity of eye blurred vision	Mild	Moderate	Severe	Very severe
97. Frequency of eye halos	At least once a week	At least once a month	At least once a month	At least once a month
98. Severity of eye halos	Mild	Moderate	Severe	Very severe
99. Frequency of eye double vision	At least once a week	At least once a month	At least once a month	At least once a month
100. Severity of eye double vision	Mild	Moderate	Severe	Very severe

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10

Plan

Introduction

Methods

Results

Conclusions

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11

Results – general descriptive

- 107 participants; 36% male
- Mean age 31y (SD 5.25, range 20-40y)
- Median PC use 8h a day
- No ocular pathology or poor VA

Variable	Median (IQR)	Range (D)
SER	RE -0.25 LE -0.25	1.88 -7.62 to +2.75
Cylinder	RE -0.25 LE -0.25	0.50 -2.50 to 0.00
Amplitude of accommodation (mean RL)	7.00	4.50 3.00 to 15.00
MEM retinoscopy (mean RL)	+1.00	+1.00 -1.50 to +2.75

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12

Which lens power was subjectively preferred?

- Data available for 84 participants
- 69% able to choose one option
- When could not choose, weighting system used
- Preferences
 - 20% control lens
 - 25% +0.50
 - 47% +0.75
 - 8% +1.25

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13

Why is +0.75D often preferred?

- Not due to age
- Not explained by amplitude of accommodation
- Not explained by lag of accommodation (except for the 3 participants who chose +1.25)
- N.B., participants viewed text at normal VDU distance, ~40-110cm
 - When >80cm, +1.25 would be over-powered

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14

Which lens power gives best performance?

- Data available for 107 participants
- Faster with +0.50 and +0.75 than control (p<0.005)
- With plus; 24% read >10% faster & 8% >15% faster
- Fastest with
 - Control: 12%
 - +0.50: 19%
 - +0.75: 51%
 - +1.25: 18%

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15

Does the preferred lens give best performance?

- For the 58 participants who were able to decide on one lens, this was the lens giving best performance in 28% of cases
 - Kendall correlation 0.71 (p=0.052)
- Including participants who ranked more than one lens as equal best, this agreed with best performance in 49% of cases
 - Kendall correlation 0.36 (p=0.072)

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16

Why fastest with +0.75D?

- Not due to age
- Not explained by amplitude of accommodation
- Not explained by lag of accommodation
- N.B., participants viewed text at normal VDU distance, ~40-110cm
 - When >80cm, +1.25 would be over-powered

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17

How about dry eye?

- DEWS score max 36 (range: 9-17), no-one reached 50%
- SANDE score median 53 (IQR 31.00, range 1-90)
 - Typical of a dry eye population (median 52; Amparo & Dana, 2018)
- Participants with the most severe dry eye symptoms perform worst at the WRRT
 - Supports previous research (Ridder et al., 2013; Ousler et al., 2015)

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18

Is DES multi-factorial?

- Caution: multiple correlations

Variable	CVS-Q	SANDE	DEWS	Subjective refraction	WRRT	DES HRS
CVS-Q	1.000	0.469 p<0.005	0.259 p=0.007	-0.028 p=0.723	-0.102 p=0.128	0.012 p=0.868
SANDE	0.469 p<0.005	1.000	0.248 p=0.001	-0.040 p=0.604	-0.089 p=0.179	0.128 p=0.069
DEWS	0.259 p<0.005	0.597 p=0.005	1.000	0.022 p=0.785	-0.036 p=0.614	0.038 p=0.615
Subjective refraction	-0.028 p=0.723	-0.040 p=0.604	0.022 p=0.785	1.000	-0.017 p=0.823	0.017 p=0.831
WRRT	-0.102 p=0.128	-0.089 p=0.179	-0.036 p=0.614	-0.017 p=0.823	1.000	0.065 p=0.361
DES HRS	0.012 p=0.868	0.128 p=0.069	0.038 p=0.615	0.017 p=0.831	0.065 p=0.361	1.000

- Yes, of course!



19

Plan

Introduction

Methods

Results

Conclusions



20

Conclusions

- 80% of people with DES prefer plus, most often +0.75
- +0.75 is also best for performance
 - 51% read fastest with +0.75
 - Correlation between preference and performance is modest ($\tau = 0.36$ to 0.71)
 - The preference for +0.75 is not explained by age or accommodation; may be related to viewing distance
 - Supports the application of low plus/accommodative support lenses for DES
- DES is multifactorial
 - Dry eye also influences performance at WRRT



21