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Keywords
computers, vision, eyeglasses, glasses, accomodative response

Disciplines
Ophthalmology | Optometry

Comments
This original research manuscript has not undergone peer review.

Gunnar Optiks Study: Electromyography and Tear Volume (2008)

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Abstract

A second study of 38 subjects, ages 22-62, was conducted to study the difference between Gunnar Optiks computer spectacles and control glasses with small changes in base curve or tint. The two control pairs of eyeglasses were in similar frames, and both sets of lenses were made of similar resin with antireflective coating. One control pair had gray-tinted lenses were made with the same optical power as the Gunnar Optiks design. The other had the same yellow tint, but a flatter base curve and face form than the Gunnar design. Under stressful conditions of glare and dry air induced by a fan, electromyography of the eyelid to quantify squinting and blinking, tear volume measurement using Zone Quick phenol red thread, and subjective symptoms experienced with each type of glasses were made. Statistical analysis revealed no significant difference between the Gunnar Optiks design and the control glasses under these conditions.

Background

This study was designed to evaluate Gunnar Optiks eyeglasses. According to the company website (www.gunnaroptiks.com), these computer eyeglasses are designed to deliver the following to the eyes:

- Glare reduction
- Higher humidity
- Extraneous light diminution
- Screen magnification
- Ultraviolet (UV) protection

Methods

Subjects were between the ages of 22 and 62, with a mean age of 31 years. There were 38 subjects who participated in the study, and 29 whose data qualified for statistical analysis. 17 were male and 12 were female.

To qualify for the study, all subjects had to have 20/20 acuity in both their right and left eyes, either without correction, or with contact lens correction. In addition, each subject's residual refractive error could not exceed 0.62 D spherical equivalent in either eye. Those wearing corrective spectacles only were not qualified as the Gunnar Optiks were not made available in individual prescriptions.

After initial recruitment and qualification, each participant had their visual symptoms surveyed with a symptom survey (see Appendix). Then, two surface electrodes for electromyography (EMG) were positioned on the lower orbicularis muscle of each eyelid. These were used to count blinks and quantify squinting. To simulate the average work environment, each subject was tested while scanning an electronic database on a desktop computer with a 50 cm working distance under the following conditions:

1) Control (no glasses, no stressors)

2) Gunnar Optiks spectacles (with original +0.50 D power), with a blowing fan directed toward the subject's face to cause dryness

3) A flatter (4D) BC Izod spectacles, with lenses identical to the Gunnar design, also with a blowing fan

4) Gunnar Optiks spectacles with glare, caused by five 15W compact fluorescent lights (color temperature: 6500 K), causing 300W incandescent-equivalent glare

5) A gray-tinted pair of spectacles, in a frame of Gunnar Optiks' design, also with the same glare

6) Gunnar Optiks spectacles with no fan or glare stressors

7) Clear (placebo) glasses, without tint or optical power, in a frame of Gunnar Optiks' design, with no stressors

All but the first condition were randomized in a Latin-square order for each subject. Symptom surveys (see appendix) were administered before and after each condition. Tear volume measurements using Zone Quick phenol red cotton threads were used to test one eye for dryness both before and after the conditions with the blowing fan stressor and the control conditions. Comprehension was monitored with a multiple-choice questionnaire.

Statistical Methods

Conditions were compared with a mixed model analysis of variance or covariance. In the case of EMG, blink, and squint measures the initial 30-second period of each condition was used as a covariate. During this period, the subject did not wear any of the spectacles. Left and right eyes were treated as a random variable. EMG power and squint duration were log transformed to better represent a normal distribution.

Individual symptom measures were combined into a priori scales using principal components analysis. The 1-100 scale responses were first log transformed and then z scores were computed using each subjects individual mean and standard

deviation across conditions. This removed the covariance due to the within subjects effect of condition. The principal components analysis was then run separately for each predefined scale. Factor scores were computed using the Anderson Rubin transformation. The resulting standard scores were then converted back to the original log scale, restoring the differences between subjects. A mixed model ANOVA framework was then employed to test the overall effect of condition and derive the standard errors for individual tests of the differences between conditions. Geometric means are presented to restore the original 1-100 scale.

The symptom scales were presented with tic marks at 1, 25, 50, 75, and 100. The subject could mouse click anywhere along the line. We arbitrarily chose a score of 20 or greater as an indication of the presence of a symptom. For each symptom a crosstab was constructed with the number of people with or without a symptom by the condition. Expected values were computed given the margin totals of the crosstab. An adjusted standardized residual (z score) was computed for each cell.

Graphs were constructed by to compare the means. Confidence intervals were constructed such that non-overlapping confidence intervals were significantly different at an unadjusted $p<0.05$. This was accomplished by constructing the 84th percent confidence interval around each mean[1]. In constructing this confidence interval the standard error for a single mean (SE) was estimated using the standard error of the differences (SED) in the following formula: SE = SED/(square root of 2). The standard error of the differences between means was the same as used in the least squared difference t-test (SPSS version 17; SPSS Inc. Chicago, Ill.)

Table 1. Conditions

	Tint	Wrap
Yellow Glasses w/ Glare	Yellow	Yes
Gray Glasses w/ Glare	Gray	Yes
Yellow Glasses w/ Fan	Yellow	Yes
Izod Glasses w/ Fan	Yellow	No
Yellow Glasses	Yellow	Yes
Clear Glasses	None	Yes
No Glasses	None	No

Results

Twenty nine (29) subjects met the study inclusion and exclusion criteria and completed the study.

EMG, Squint, and Blink analysis. When comparing the conditions, only blink frequency per minute had an overall significant F in the ANCOVA (see Table 2). Figures 1-3 are presented comparing means for Blink frequency, EMG Power, and squint frequency.

Tearing. There was no statistical difference between tears generated under fan conditions for the Izod glasses (22.01 mm, 1.06SE) and Gunnar yellow glasses (23.95 mm, 1.95SE) ($p = .13$). The reference group with no glasses and no fan had a mean 20.72 mm, 1.07SE.

Note that tear volume is measured after 15 seconds of insertion of the phenol red cotton threads in the lower lid, as directed by the Zone Quick manufacturer. Although there was an almost 3 mm difference between the control condition (without glasses and the fan), we interpreted the (almost) 24 mm tear volume with the Gunnar glasses as reflex tearing due to the fan alone.

Symptoms. Tables 3a-c present the raw data for the individual symptom measures categorized by summary scale. Comments on each are in the captions. **See summary tables on following pages**.

Conclusions and Recommendations

From the data in the tables, the following conclusions can be made:

1. Without stressors such as a blowing fan, the Gunnar Optiks design did not reduce EMG squinting power. Thus, patients would be expected to squint just as strongly with or without the Gunnar glasses under these conditions.

2. EMG blink rate was lowest under glare conditions with Gunnar glasses. A lower blink rate is generally associated with dry eyes, therefore, the Gunnar Optiks design can not be concluded to reduce dry eye symptoms by increasing blink rate.

3. EMG squint frequency was highest with the Gunnar design glasses even without other stress conditions, and lowest under glare conditions with either yellow or gray tint. Gunnar Optiks design does not reduce squinting more than other colors of tint would, even under glare.

4. The Gunnar Optiks design did not decrease the internal symptoms of sore eyes, tired eyes and eyestrain compared to control conditions.

5. External symptoms of dry, burning or watering eyes were not reduced with the Gunnar design compared to the other designs under stressful and non-stressful conditions. Thus, we were not able to reproduce the subjective results of the first Gunnar Optiks study we did in 2007.

6. Symptoms of back, neck and shoulder pain were highest

with the Gunnar design glasses and glare stressor, and lowest with no glasses. The Gunnar design did not reduce these physical symptoms.

7. The Gunnar Optiks design did not reduce blur or double vision subjectively.

8. Blink-related symptoms were not significantly different with the Gunnar Optiks design compared with the flatter base curve Izod glasses.

9. Environmental symptoms, such as poor contrast, glare and small font size, were worst with the Gunnar spectacles under glare conditions, and best with no glasses or at baseline.

10. All negative psychological symptoms were statistically the same regardless of spectacles worn.

11. In terms of positive psychological symptoms, the Gunnar Optiks design without stressors did show a significant difference from baseline, but subjects did prefer them to no glasses at all. This replicates the finding of the 2007 study in which 59% of the subjects preferred the original +0.50 D power Gunnar design.

In summary, these studies have not found scientific evidence for a change in accommodation (focusing), tear volume, or electromyography of the eyelid (squinting and blinking). Despite this, there seems to be some subjective preference for the Gunnar design. This preference may simply be due to the placebo effect, but is still real to these subjects. While not encouraging, these results are tempered by the lack of evaluation of a large group of potential subjects: corrective spectacle wearers.

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Notes and references

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[1] Payton ME, Greenstone MH, Schenker N. 2003. Overlapping confidence intervals or standard error intervals: What do they mean in terms of statistical significance? 6pp. *Journal of Insect Science*, 3:34, Available online: insectscience.org/3.34

TABLES: ***Gunnar Optiks Study: Electromyography and Tear Volume (2008)***

Condition	log EMG Power	Average Blink Power	Blink Frequency per minute	Average Blink Duration (msec)	Average Squint Power	Squint Frequency per minute	Log Average Squint Duration (sec)
Yellow Glasses w/ Glare	4.719	13.828a	18.767	52.900	12.855	1.617	2.380
Gray Glasses w/ Glare	4.620	13.487a	16.917	50.800	13.130	1.388	2.250
Yellow Glasses w/ Fan	4.623	13.408a	20.216	53.900	13.249	1.931	2.220
Izod Glasses w/ Fan	4.762	13.657a	19.831	52.600	13.301	2.796	2.332
Yellow Glasses	4.712	13.700a	21.224	53.700	13.348	3.198	2.238
Clear Glasses	4.591	13.445a	23.616	52.500	12.483	2.429	2.225
No Glasses	4.782	13.813a	22.705	54.480	13.092	1.806	2.223
ANOVA F	1.883	1.146	2.573	.402	1.351	2.065	1.370
P	.083	.335	.002	.877	.238	.057	.229

Table 3a. Symptom frequency. Adjusted residual scores (z-scores) greater than 2 are significant at an approximate unadjusted $p<0.05$. Negative z scores reflect fewer symptoms than expected by chance and positive z-scores reflect more symptoms than expected by chance. **The findings with the greatest absolute values, in bold, shows that with the blowing fan stress conditions, subjects experienced dry and burning eyes.**

		Internal			External			Physical		
		Sore	Eyestrain	Tired Eyes	Burning	Dry Eyes	Watery Eyes	Neck Shoulder Pain	Back Pain	Total
Baseline	Count	8	6	8	8	13	4	5	6	29
	Expected Count	10.1	7.9	19.3	13.4	18.3	5.7	6.3	8.4	29.0
	Adjusted Residual	-.9	-.9	**-4.8**	**-2.2**	**-2.2**	-.9	-.6	-1.1	
Yellow Glasses with Glare	Count	12	8	22	11	20	6	8	11	29
	Expected Count	10.1	7.9	19.3	13.4	18.3	5.7	6.3	8.4	29.0
	Adjusted Residual	.8	.0	1.1	-1.0	.7	.1	.8	1.1	
Gray Glasses with Glare	Count	12	8	19	11	14	5	7	8	27
	Expected Count	9.4	7.4	18.0	12.5	17.0	5.4	5.8	7.9	27.0
	Adjusted Residual	1.1	.3	.5	-.6	-1.3	-.2	.6	.1	
Yellow Glasses with Fan	Count	10	8	21	20	23	6	7	8	27
	Expected Count	9.4	7.4	18.0	12.5	17.0	5.4	5.8	7.9	27.0
	Adjusted Residual	.3	.3	1.3	**3.1**	**2.5**	.3	.6	.1	
Izod Glasses with Fan	Count	12	9	22	22	27	9	6	9	29
	Expected Count	10.1	7.9	19.3	13.4	18.3	5.7	6.3	8.4	29.0
	Adjusted Residual	.8	.5	1.1	**3.4**	**3.6**	1.6	-.1	.2	
Yellow Glasses	Count	8	7	21	11	15	7	5	9	28
	Expected Count	9.7	7.6	18.6	13.0	17.6	5.6	6.0	8.1	28.0
	Adjusted Residual	-.7	-.3	1.0	-.8	-1.1	.7	-.5	.4	
Clear Glasses	Count	9	10	22	14	14	5	7	11	29
	Expected Count	10.1	7.9	19.3	13.4	18.3	5.7	6.3	8.4	29.0
	Adjusted Residual	-.5	.9	1.1	.2	-1.8	-.4	.4	1.1	
No Glasses	Count	8	6	16	8	17	3	4	4	29
	Expected Count	10.1	7.9	19.3	13.4	18.3	5.7	6.3	8.4	29.0
	Adjusted Residual	-.9	-.9	-1.4	**-2.2**	-.5	-1.4	-1.1	-1.9	
	Total Count	79.0	62.0	151.0	105.0	143.0	45.0	49.0	66.0	227.0

Table 3b. Symptom frequency. Adjusted residual scores (z-scores) greater than 2 are significant at an approximate unadjusted $p<0.05$. Negative z scores reflect fewer symptoms than expected by chance and positive z-scores reflect more symptoms than expected by chance. **Note that under the glare stress conditions, subjects experienced poor contrast and were bothered by glare with both pairs of tinted spectacles.**

		Vision			Blink		Environment				
		Double	Blur	Headache	Blink Harder	Blink More	Contrast Too Bright	Contrast Too Dim	Glare	Font Size	Total
Baseline	Count	3	2	3	5	9	3	1	2	2	29
	Expected Count	1.9	2.2	5.1	13.5	17.1	1.9	3.6	3.2	2.8	29.0
	Adjusted Residual	.9	-.1	-1.1	**-3.4**	**-3.3**	.9	-1.6	-.8	-.5	
Yellow Glasses with Glare	Count	1	3	5	13	20	4	8	13	5	29
	Expected Count	1.9	2.2	5.1	13.5	17.1	1.9	3.6	3.2	2.8	29.0
	Adjusted Residual	-.7	.6	-.1	-.2	1.2	1.7	**2.7**	**6.2**	1.5	
Gray Glasses with Glare	Count	1	1	5	11	15	1	7	8	4	27
	Expected Count	1.8	2.0	4.8	12.6	15.9	1.8	3.3	3.0	2.6	27.0
	Adjusted Residual	-.6	-.8	.1	-.7	-.4	-.6	**2.3**	**3.3**	1.0	
Yellow Glasses with Fan	Count	3	4	7	18	20	1	1	0	1	27
	Expected Count	1.8	2.0	4.8	12.6	15.9	1.8	3.3	3.0	2.6	27.0
	Adjusted Residual	1.0	1.5	1.2	**2.2**	1.7	-.6	-1.5	-1.9	-1.1	
Izod Glasses with Fan	Count	2	2	5	20	25	2	4	2	2	29
	Expected Count	1.9	2.2	5.1	13.5	17.1	1.9	3.6	3.2	2.8	29.0
	Adjusted Residual	.1	-.1	-.1	**2.6**	**3.2**	.1	.3	-.8	-.5	
Yellow Glasses	Count	2	2	5	13	15	1	4	0	2	28
	Expected Count	1.9	2.1	4.9	13.1	16.5	1.9	3.5	3.1	2.7	28.0
	Adjusted Residual	.1	-.1	.0	.0	-.6	-.7	.3	**-2.0**	-.5	
Clear Glasses	Count	2	2	7	15	16	1	2	0	4	29
	Expected Count	1.9	2.2	5.1	13.5	17.1	1.9	3.6	3.2	2.8	29.0
	Adjusted Residual	.1	-.1	1.0	.6	-.5	-.7	-1.0	**-2.0**	.8	
No Glasses	Count	1	1	3	11	14	2	1	0	2	29
	Expected Count	1.9	2.2	5.1	13.5	17.1	1.9	3.6	3.2	2.8	29.0
	Adjusted Residual	-.7	-.9	-1.1	-1.0	-1.3	.1	-1.6	**-2.0**	-.5	
	Count	15	17	40	106	134	15	28	25	22	227
	Expected Count	15.0	17.0	40.0	106.0	134.0	15.0	28.0	25.0	22.0	227.0

Table 3c. Symptom frequency. Adjusted residual scores (z-scores) greater than 2 are significant at an approximate unadjusted $p<0.05$. Negative z scores reflect fewer symptoms than expected by chance and positive z-scores reflect more symptoms than expected by chance. **Note that none of the experimental conditions showed these psychological symptoms increased or decreased with any of the spectacles tested.**

		Negative					Positive					Total
		Frustrated	Anxious Tense	Discouraged	Tired	Wander	Alert Energy	Better Concentration	Relaxed	Cheerfulness	Motivated	
Baseline	Count	4	8	6	6	10	10	9	11	10	12	29
	Expected Count	6.0	5.9	3.7	10.6	17.5	5.4	6.6	5.9	6.0	5.7	29.0
	Adjusted Residual	-1.0	1.1	1.4	-1.9	**-3.0**	**2.4**	1.1	**2.5**	**2.0**	**3.1**	
Yellow Glasses with Glare	Count	8	5	4	11	20	5	9	4	4	4	29
	Expected Count	6.0	5.9	3.7	10.6	17.5	5.4	6.6	5.9	6.0	5.7	29.0
	Adjusted Residual	1.0	-.4	.2	.2	1.0	-.2	1.1	-.9	-1.0	-.9	
Gray Glasses with Glare	Count	7	5	4	13	21	3	3	6	5	3	27
	Expected Count	5.6	5.5	3.4	9.9	16.3	5.0	6.2	5.5	5.6	5.4	27.0
	Adjusted Residual	.7	-.2	.3	1.3	2.0	-1.1	-1.6	.3	-.3	-1.2	
Yellow Glasses with Fan	Count	8	7	3	12	17	5	3	5	6	6	27
	Expected Count	5.6	5.5	3.4	9.9	16.3	5.0	6.2	5.5	5.6	5.4	27.0
	Adjusted Residual	1.2	.8	-.3	.9	.3	.0	-1.6	-.2	.2	.3	
Izod Glasses with Fan	Count	7	8	6	14	21	4	5	3	4	3	29
	Expected Count	6.0	5.9	3.7	10.6	17.5	5.4	6.6	5.9	6.0	5.7	29.0
	Adjusted Residual	.5	1.1	1.4	1.4	1.4	-.7	-.8	-1.4	-1.0	-1.4	
Yellow Glasses	Count	4	4	1	12	18	7	8	5	8	6	28
	Expected Count	5.8	5.7	3.6	10.2	16.9	5.2	6.4	5.7	5.8	5.6	28.0
	Adjusted Residual	-.9	-.8	-1.6	.7	.5	.9	.8	-.3	1.1	.2	
Clear Glasses	Count	6	5	2	9	21	5	6	7	5	5	29
	Expected Count	6.0	5.9	3.7	10.6	17.5	5.4	6.6	5.9	6.0	5.7	29.0
	Adjusted Residual	.0	-.4	-1.0	-.7	1.4	-.2	-.3	.6	-.5	-.4	
No Glasses	Count	3	4	3	6	9	3	9	5	5	6	29
	Expected Count	6.0	5.9	3.7	10.6	17.5	5.4	6.6	5.9	6.0	5.7	29.0
	Adjusted Residual	-1.5	-.9	-.4	-1.9	**-3.5**	-1.2	1.1	-.4	-.5	.1	
	Count	47	46	29	83	137	42	52	46	47	45	227
	Expected Count	47.0	46.0	29.0	83.0	137.0	42.0	52.0	46.0	47.0	45.0	227.0

Figure 1 (below) shows how strongly subjects squinted during the experiment. Note that the strongest squinting occurred with no glasses, and the least with clear (placebo) glasses, although those were very similar to spectacles with either yellow or gray tint. Note that without stressors, the Gunnar Optiks design did not reduce EMG power. See below.

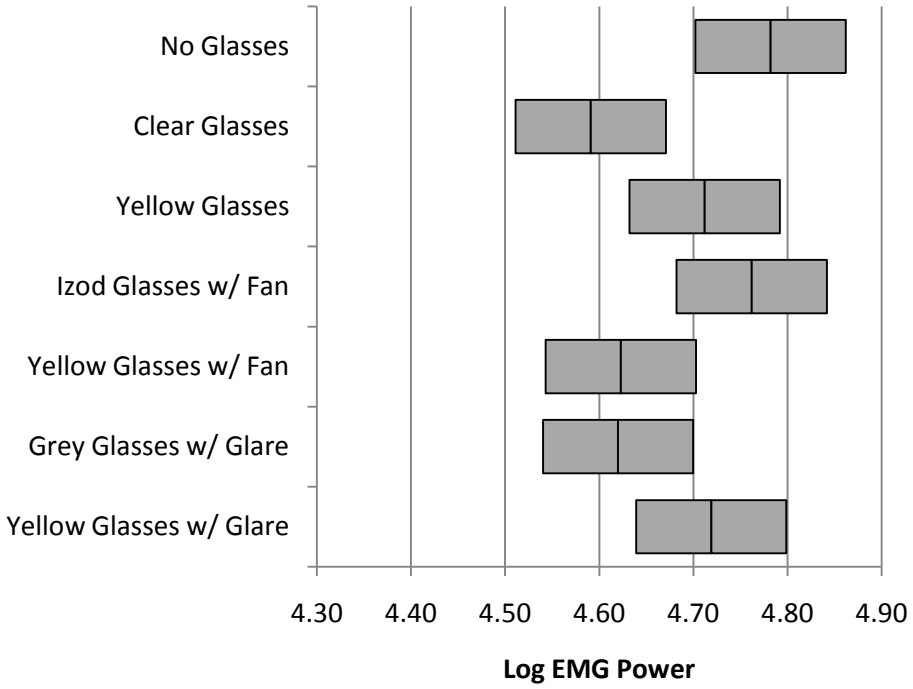

Figure 1. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F = 1.88, p=0.083).

Figure 2 shows blink rate, which was highest with no glasses or clear (placebo) glasses, and lowest under glare conditions with tinted glasses of yellow or gray color. A lower blink rate is generally associated with dry eyes. See below.

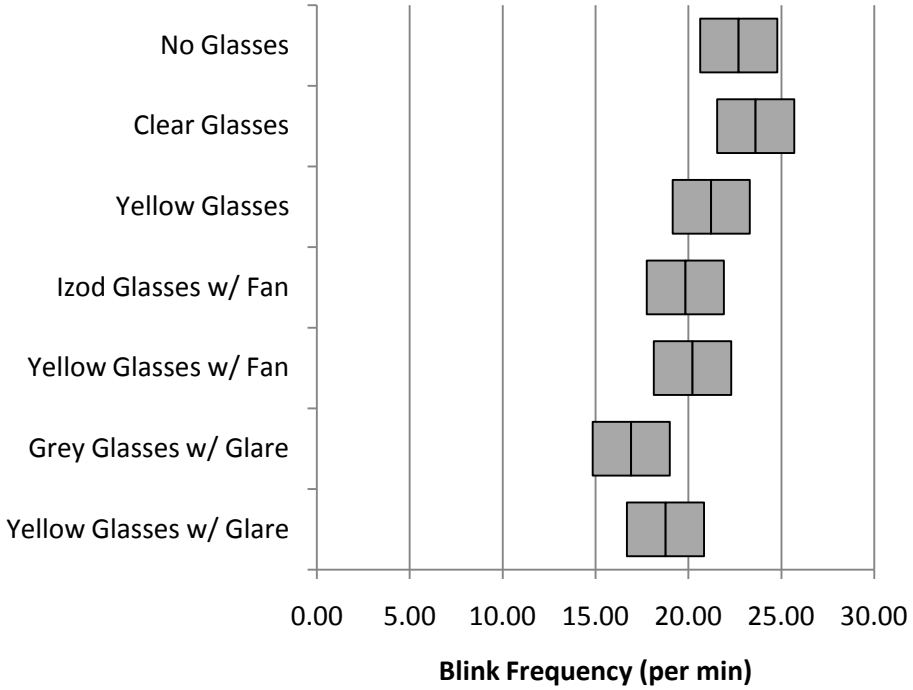

Figure 2. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F = 2.57, p=0.019).

Figure 3 shows squint frequency, which was highest with the Gunnar design glasses without other stress conditions, and lowest under glare conditions with either yellow or gray tint. This paradoxical relationship is not easily explained. See below.

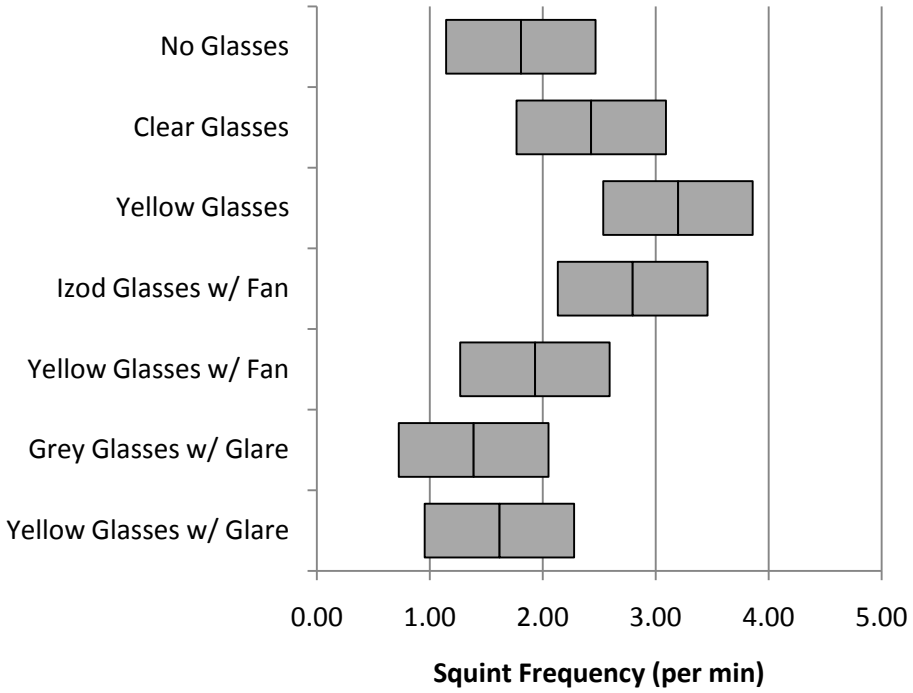

Figure 3. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F = 2.065, p=0.057).

Figure 4 shows internal symptoms, namely sore eyes, tired eyes, and eyestrain are lowest under baseline conditions and with no glasses, but equally high under the other conditions. The Gunnar Optiks design did not decrease these internal symptoms. See below.

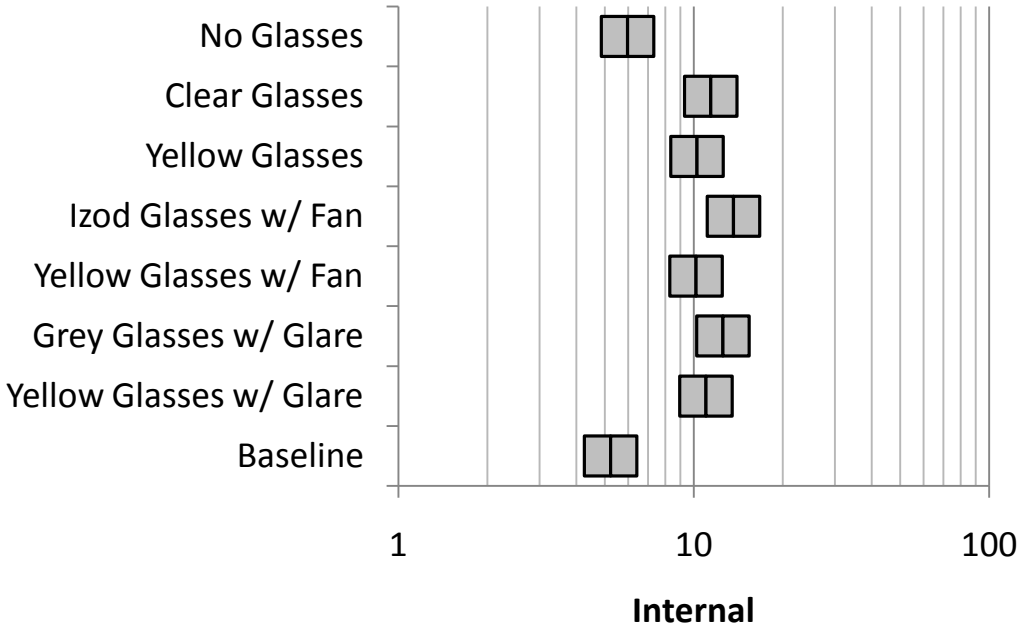

Figure 4. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F = 5.89, p<0.001).

Figure 5 shows external symptoms, namely burning eyes, dry eyes, and watery eyes. Note these symptoms are highest with the blowing fan conditions, and lower under the other conditions. Baseline was lowest of all. Symptoms were not reduced with the Gunnar design compared to the other designs under stressful and non-stressful conditions. See below.

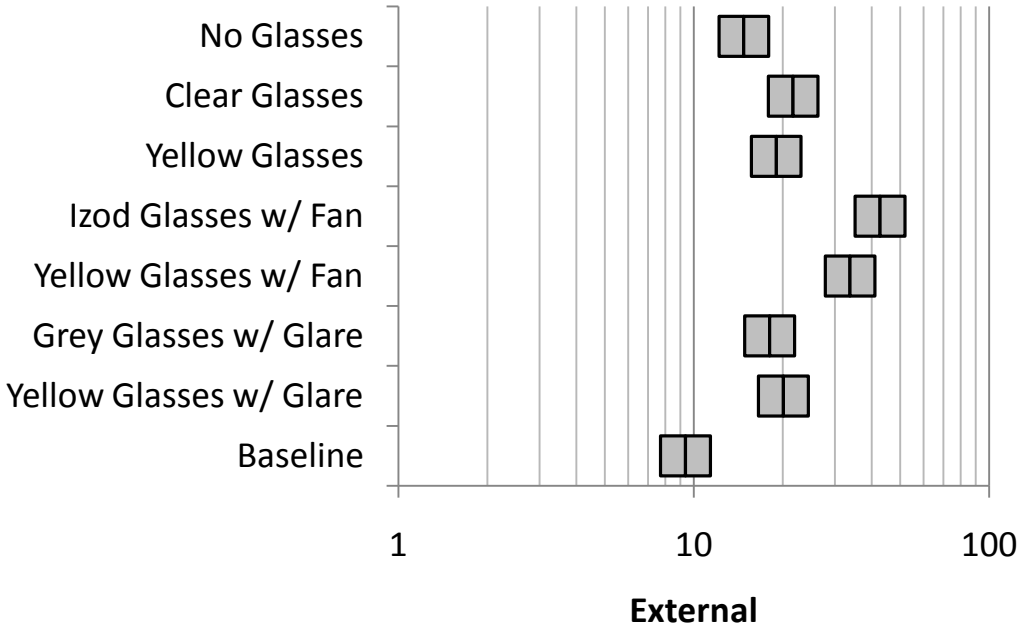

Figure 5. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F=11.9, p<0.001).

Figure 6 shows physical symptoms back, neck and shoulder pain. Note these symptoms were highest with the Gunnar design glasses and glare stressor, and lowest with no glasses and at baseline conditions. This was not expected. These data are shown below.

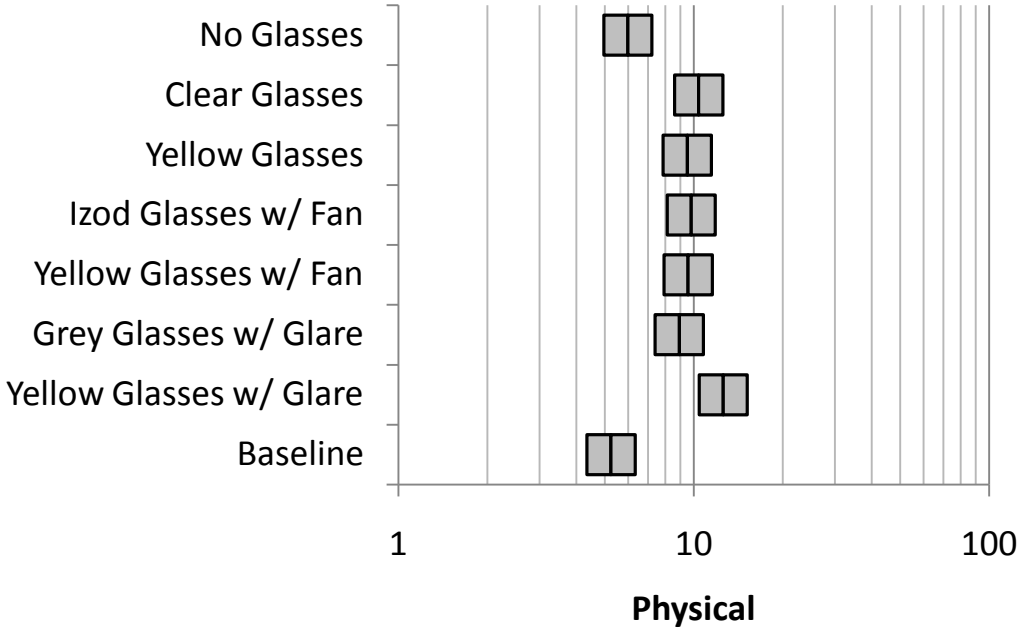

Figure 6. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F=5.02, p<0.001).

Figure 7 shows the vision symptoms of double vision and blur. These symptoms were extremely similar under all conditions except the no glasses and baseline conditions, which were slightly less symptomatic. The Gunnar Optiks design did not reduce blur subjectively to these subjects. See below.

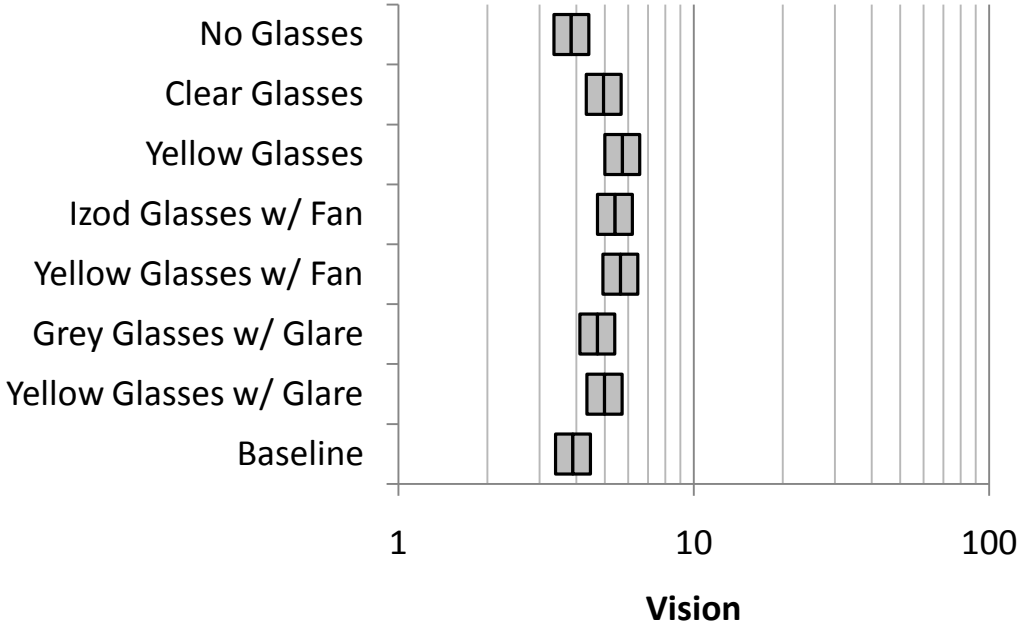

Figure 7. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F= 2.67, p=0.014).

Figure 8 shows the symptoms that relate to blinking, namely blinking harder and blinking more. These data are more scattered – highest, as expected, under conditions with the blowing fan, and lowest with the baseline condition. Note that the symptoms were not significantly different with the Gunnar Optiks design compared with the flatter base curve Izod glasses. See below.

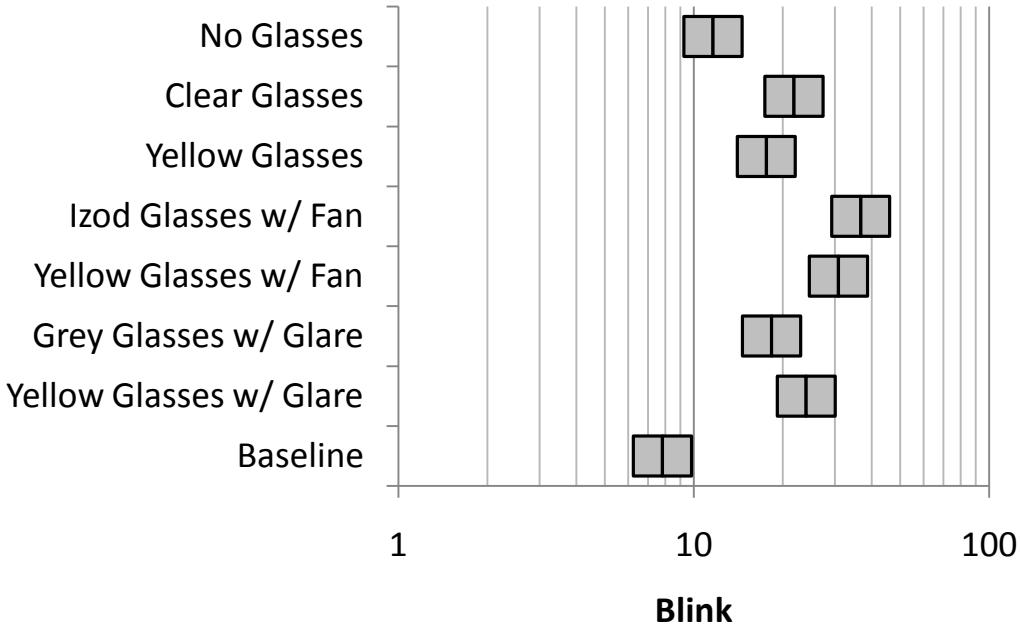

Figure 8. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F= 10.28, p<0.001).

Figure 9 shows environmental symptoms, such as poor contrast, glare and small font size, were worst with the Gunnar spectacles under glare conditions, and best with no glasses or at baseline. The Gunnar design performed better than most others with the blowing fan stressor, but not statistically better than the clear (placebo) glasses. See below.

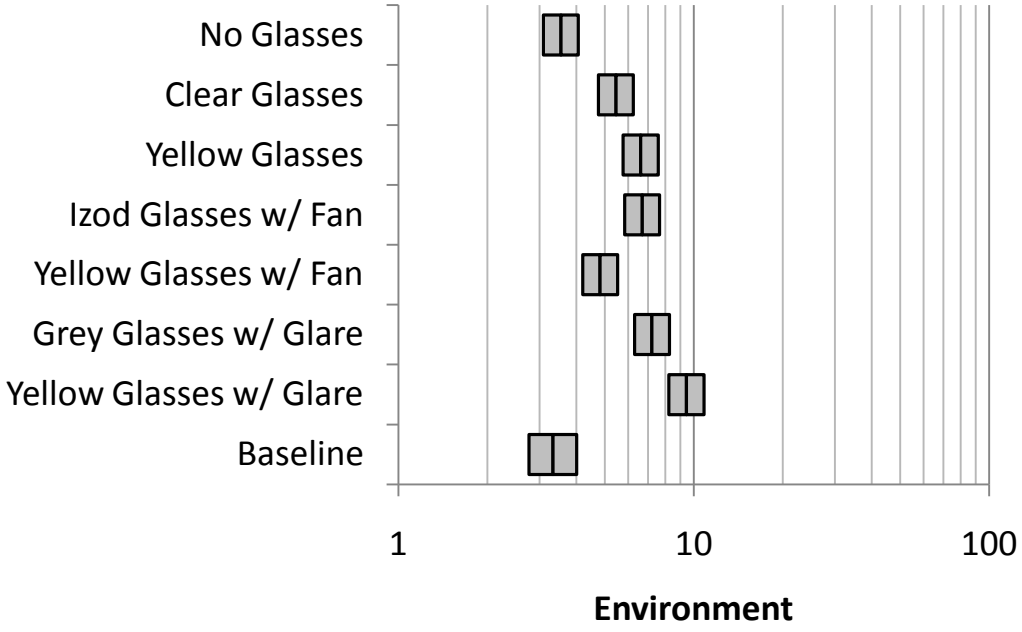

Figure 9. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F=7.75, p<0.001).

Figure 10 compares the negative psychological symptoms (frustration, anxiety, tension, discouragement, fatigue and wandering attention). All of these symptoms were statistically the same regardless of spectacles worn. Only the no glasses condition was similar to baseline. See below.

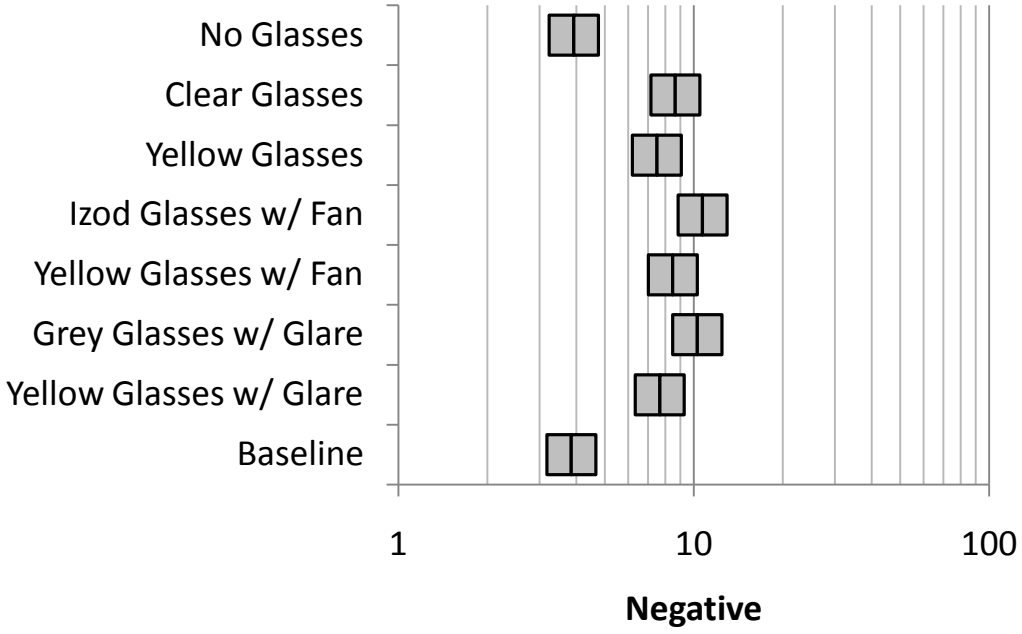

Figure 10. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F = 8.94, p<0.001).

Lastly, figure 11 compares the positive psychological symptoms (attentive, better concentration, relaxed, cheerful and motivated). Most of these symptoms clustered together. The Gunnar Optiks design without stressors did show a significant difference from no glasses at all on this scale, though they were not significantly different from baseline. See below.

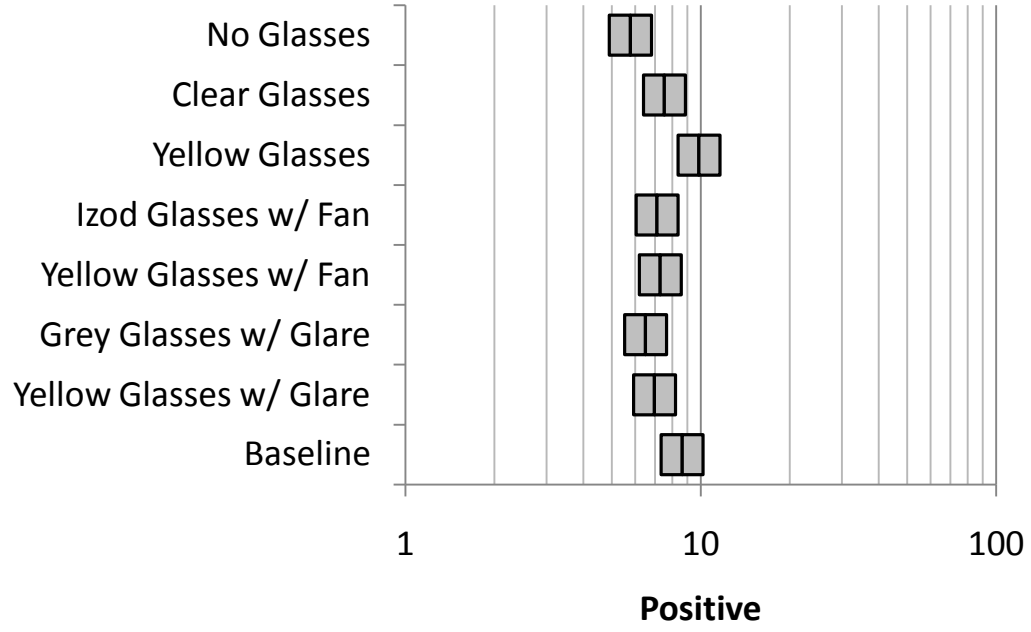

Figure 11. Non-overlapping bars indicate statistical significance at an unadjusted p<0.05 (F = 2.07, p=0.048).

Appendix: VERL Digital Sensation Questionnaire

For each of the following symptoms, circle the word that best represents the severity of each item during reading while wearing your computer glasses:

Sore eyes, painful eyes, or ache in or around eyes

none mild moderate bad severe

Double vision

none mild moderate bad severe

Blurred vision

none mild moderate bad severe

Headache

none mild moderate bad severe

Eyestrain or pulling of the eye muscles

none mild moderate bad severe

Irritation or burning of the eyes

none mild moderate bad severe

Tearing, or watery eyes

none mild moderate bad severe

Dry eyes

none mild moderate bad severe

Tired eyes

none mild moderate bad severe

Bothered by brightness

none mild moderate bad severe

Bothered by glare

none mild moderate bad severe

Computer screen fonts look too small

none mild moderate bad severe

Computer screen colors are distorted

none mild moderate bad severe

Computer screen clarity is poor

none mild moderate bad severe

Desire to blink harder

none mild moderate bad severe

Desire to blink more often

none mild moderate bad severe

Difficult to concentrate on the text

none mild moderate bad severe

Difficult to comprehend the text

none mild moderate bad severe

Difficult to remember the text

none mild moderate bad severe

Feel sleepy / Eyelids feel heavy

none mild moderate bad severe

Feel dizzy

none mild moderate bad severe

Desire to adjust the viewing distance (move closer or further away from the screen)

none mild moderate bad severe

Desire to stop the condition or take a break

none mild moderate bad severe