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Abstract

This retrospective study compared the heterophorias, near point of convergence, and near vergence ranges between presbyopes and non-presbyopes. A population of 170 subjects were equally divided into two sample groups of 85 each. Significant differences at the ($p<0.05$) level between the presbyopic and non-presbyopic populations were found for near phoria. Presbyopes showed increasing exophoria with age at near. Significant differences at near were also found for near point of convergence, base outrecoveries, base in breaks and recoveries. The two categories that did not yield a statistically significant difference were distance phoria and near base out-break. Presbyopes may be at greater risk for near point asthenopia due to this significant decrease in convergence ability.

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A Comparison of Heterophoria, Near Point of Convergence and Vergence Ranges at Near between Presbyopes and Non-presbyopes.

by

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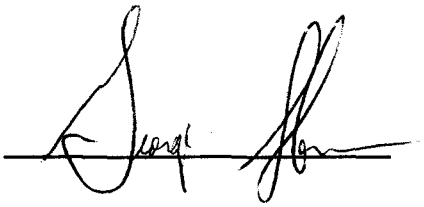
Author: George Shen 

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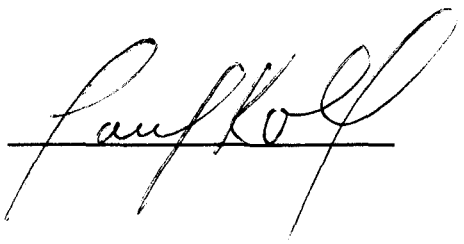
Advisor: Paul Kohl, O.D. 

ABSTRACT

This retrospective study compared the heterophorias, near point of convergence, and near vergence ranges between presbyopes and non-presbyopes. A population of 170 subjects were equally divided into two sample groups of 85 each. Significant differences at the ($p<0.05$) level between the presbyopic and non-presbyopic populations were found for near phoria. Presbyopes showed increasing exophoria with age at near. Significant differences at near were also found for near point of convergence, base out-recoveries, base in breaks and recoveries. The two categories that did not yield a statistically significant difference were distance phoria and near base out-break. Presbyopes may be at greater risk for near point asthenopia due to this significant decrease in convergence ability.

INTRODUCTION

Presbyopia is defined as a reduction of accommodative ability occurring normally with age and necessitating a plus lens addition for satisfactory seeing at near, sometimes quantitatively identified by the recession of the near point of accommodation beyond 20 centimeters.

In previous studies, presbyopia has been correlated with certain binocular visual dysfunctions. In particular, it has been observed clinically that receded near point of convergence, high exophorias and reduced base out recoveries exist at near and seems to be more prevalent among the presbyopic population. These findings at near are often factors resulting in a limitation or reduction of convergence ability relative to the visual demand. This limitation of motoric fusional capability is often classified as the general binocular visual dysfunction, convergence insufficiency.

Hirsch, Alpern, and Schultz[5] found a tendency towards increased esophoria at far but towards exophoria at near with increased age as did Evans[10]. Snydacker[9] likewise reported that while the distance phoria remained constant with increased age, there was a borderline tendency towards an increased exophoria with age. He found that the increase of exophoria at near measured 1 prism diopter (pd) for every 20 years. In 1951, Morgan[6] studied 400 presbyopes and found their average near phoria to be 9 prism diopters of exophoria. Further analysis of his data implied that the increase in exophoria at near with age is due to the relaxation of accommodative convergence. In 1968, Burg[2] however, found no reason for the theory providing for alteration of the tonic convergence with age. He found a change in the lateral phoria as a function of either age or sex to be slight, falling within one standard deviation of the measurements. Extreme variability, not only in magnitude but in direction and extent of change, was manifested.

It is apparent that previous research findings, are not consistent. The purpose of this study is to derive normative data on heterophoria, vergence and near point of convergence using a clinical population generalizable to the general population.

METHODS

A retrospective study was undertaken, whereby subject files were obtained from the Pacific University College of Optometry Clinic in Forest Grove, Oregon. The subject population consisted of 170 patients. Two primary groups were randomly chosen based on age. The age range of 85 non-presbyopic subjects was 20 to 30, and the age range of the 85 presbyopes was 55 to 65. Most of the non-presbyopes and most of the presbyopic subjects were patients associated with the local community. The presbyopic subjects habitual spectacles for near could contain an add of +1.00 or more. All subjects included, were assumed to have binocular vision if no tropia existed and if phorias and vergences were obtained, and if no significant ocular health problems existed.

The required measurements gathered by interns utilize standard procedures followed at Pacific University. Measurements taken include near point of convergence (NPC), distance and near lateral heterophoria, and near vergences. The von Graefe technique of measuring the lateral phoria was employed. Vergences were measured by use of the Risley prisms in a standard phoropter. The near point of convergence was assessed in inches using a five millimeter bead.

After collecting this data, statistical analysis was utilized to obtain mean values for each measurement taken. An unpaired one-tailed t-test was used to compare mean values between groups, using ($p<0.05$) as our level of significance.

RESULTS

Tables x1-x10 summarizes the statistical means for non-presbyopes and tables x11-x20 summarizes the statistical means for the presbyopes. The non-presbyopic sample had a NPC-average of 3.1 inches. The NPC-average was obtained by averaging the mean NPC-break and mean NPC-recovery of each group. The distance phoria, was .01 pd esophoric and the near was 2.5 pd exophoric. The mean break and recoveries for the near vergence ranges were analyzed separately. They were; 16.2 pd and 8.1 pd for base out-break and base out-recovery. The near base in-break and near base in-recovery were 16.1 pd and 10.4 pd, accordingly.

The corresponding values for the presbyopes were; NPC of 5.0 inches, distance phoria of 0.3 pd esophoric and near phoria of 6.9 pd exophoric. The near base out-break and near base out-recovery were15.8 pd and 4.8 pd respectively. The base in values were 18.8 pd for the break and 12.3 pd for the recovery.

An unpaired one-tailed t-test was used to determine if the means of the two groups were significantly different from each other. The NPC-average yielded a statistically significant difference at the (p=0.0001) level between the presbyopic and non-presbyopic groups. The NPC-average for the presbyopic sample showed nearly a 2 pd decrease in mean differences between the two groups. The near phoria showed the same statistically significant difference with a mean difference of 4.4 pd more exophoria among the presbyopic sample. The near base out-recovery was also significantly different between the two groups (p=0.0003), with a 3.2 pd mean difference decrease in the presbyopic population. The near base in-break comparison showed a (p=0.0007) level with a 2.6 pd mean difference, with the presbyopes having a higher base in-break than the non-presbyopes. The near base in-recovery also showed an increase with age yielding a (p=0.0062) level of significance. The two categories that did not yield a statistically

significant difference at the ($p<0.05$) level were distance phoria ($p=0.2745$) and near base out-break ($p=0.3571$).

DISCUSSION

The comparison of the phorias and vergences showed a significant difference in the muscle balance at near between presbyopes and non-presbyopes. As graphically depicted by Fig. 1, we can see a greater than two fold change in mean phorias towards an exophoric direction when comparing the two groups. This increase in exophoria as we age can result in greater stress placed on fusional convergence and may result in discomfort, asthenopia, diplopia, and an overall inability to efficiently and comfortably perform near-centered close work. This is further compromised by an approximately forty percent outward restriction in near point convergence ranges, as found by our study (Fig. 2). For those patients who present with a decrease in ability to maintain clear and single vision at near, this may also result in a decreased ability to maintain near tasks for extended duration of time. Also found by our studies, presbyopes tend to have constricting fusional ranges. It should be noted that the mean base out recovery findings are less than the mean exophoria at near for the presbyopic group. Not only is there greater stress in terms of increasing exophoria as we age, but the ability to compensate in terms of fusional ranges decrease with age as shown by Fig. 3.

We speculate that this trio of increased exophoria, receded NPC and decreased compensatory ranges, may compromise binocular performance and cause convergence insufficiency at near working distances in the presbyopic population. However, this retrospective study does not attempt to assess subjective symptomology related with the above mentioned trio of clinical findings. Thus, the need for other research on symptom epidemiology should be considered to address the potential difference between the two groups.

For those patients with complaints of blurred vision, diplopia, headaches and asthenopia associated with convergence insufficiency, visual therapy is an effective treatment modality as suggested by Cohen and Soden.[3] There seems to be a high level of long-term success and alleviation for most patients regardless of age. Furthermore, for those presenting with the trio of increased exophoria, receded NPC and decreased compensatory ranges without subjective symptoms, Cohen and Soden[3] suggest that preventive visual therapy should also be considered.

TABLES x1-x10 (NON PRESBYOPE DESCRIPTIVE DATA)

X_1: AGE NP(NON PRESBYOPES)

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
24.447	3.002	.326	9.012	12.28	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
20	30	10	2078	51558	0

X_2: NPC(INCHES) NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
2.153	2.286	.248	5.226	106.186	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
0	12	12	183	833	0

X_3: NPC-RECOV. NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
3.947	2.408	.261	5.798	61.004	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
0	12	12	335.5	1811.25	0

X_4: NPC-AVERAGE NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
3.05	2.176	.236	4.733	71.332	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
0	12	12	259.25	1188.312	0

X_5: DIST PHORIA NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.012	2.911	.316	8.476	24746.609	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
-9	13	22	1	712	0

TABLES x1-x10 (NON PRESBYOPE DESCRIPTIVE DATA)

X_6: NEAR PHORIA NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
-2.512	4.646	.504	21.583	-184.96	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
-10	9	19	-213.5	2349.25	0

X_7: NEAR BO-BK NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
16.2	6.458	.701	41.71	39.866	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
6	36	30	1377	25811	0

X_8: NR BO-RECOV. NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
8.082	5.981	.649	35.767	73.995	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
-6	26	32	687	8557	0

X_9: NEAR BI-BK NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
16.129	4.815	.522	23.185	29.853	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
4	26	22	1371	24061	0

X_{10}: NR BI-RECOV. NP

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
10.435	4.75	.515	22.558	45.514	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
2	24	22	887	11151	0

TABLES x11-x20 (PRESBYOPE DESCRIPTIVE DATA)

X_{11}: AGE P(PRESBYOPES)

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
58.365	3.265	.354	10.663	5.595	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
55	65	10	4961	290443	0

X_{12}: NPC(INCHES) P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
4.035	3.037	.329	9.225	75.267	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
0	14	14	343	2159	0

X_{13}: NPC-RECOV. P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
5.959	3.751	.407	14.073	62.955	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
0	16	16	506.5	4200.25	0

X_{14}: NPC-AVERAGE P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
4.997	3.237	.351	10.48	64.783	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
0	15	15	424.75	3002.812	0

X_{15}: DIST PHORIA P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
.271	2.705	.293	7.319	999.793	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
-7	10.5	17.5	23	621	0

TABLES x11-x20 (PRESBYOPE DESCRIPTIVE DATA)

X_{16}: NEAR PHORIA P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
-6.882	5.074	.55	25.748	-73.728	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
-23	5	28	-585	6189	0

X_{17}: NEAR BO-BK P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
15.812	7.318	.794	53.559	46.285	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
-6	32	38	1344	25750	0

X_{18}: NR BO-RECOV. P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
4.835	6.321	.686	39.949	130.716	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
-12	22	34	411	5343	0

X_{19}: NEAR BI-BK P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
18.765	5.662	.614	32.063	30.176	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
6	32	26	1595	32623	0

X_{20}: NR BI-RECOV. P

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
12.294	4.832	.524	23.353	39.307	85
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Sqr.:**	**# Missing:**
1	24	23	1045	14809	0

FIGURE 1

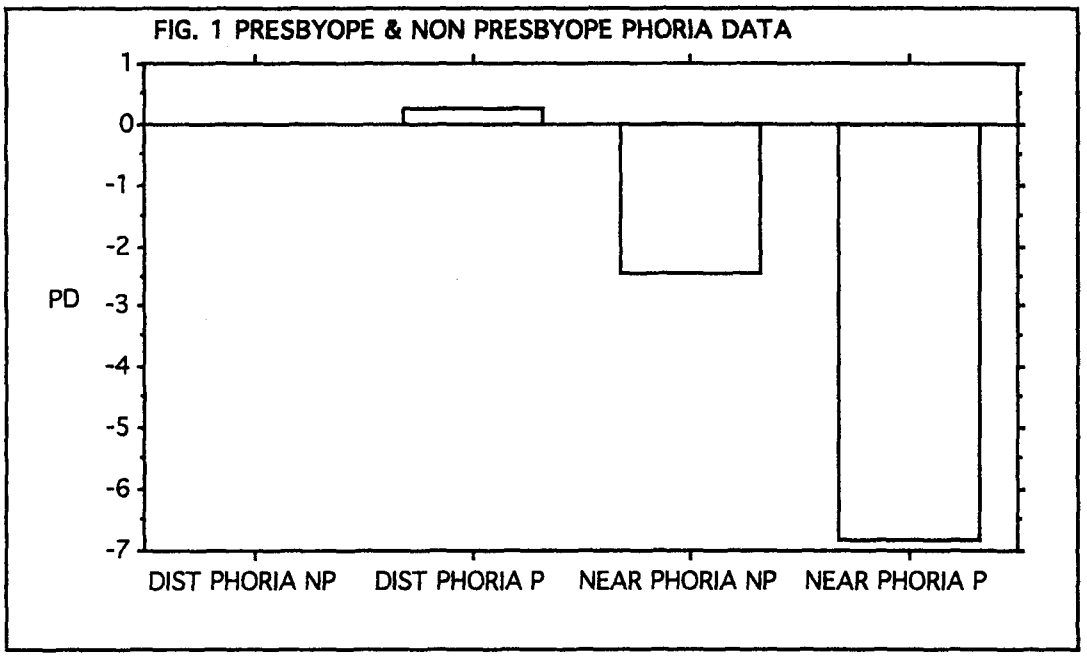


FIG. 1 PRESBYOPE & NON PRESBYOPE PHORIA DATA
PD
1
0
-1
-2
-3
-4
-5
-6
-7
DIST PHORIA NP
DIST PHORIA P
NEAR PHORIA NP
NEAR PHORIA P

FIGURE 2

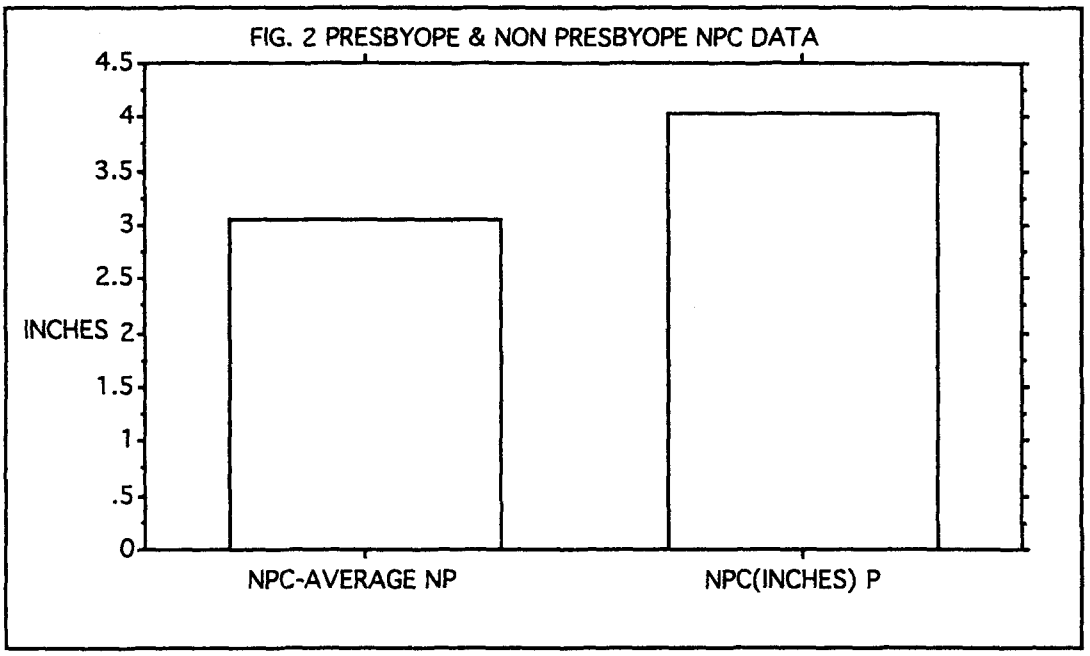


FIG. 2 PRESBYOPE & NON PRESBYOPE NPC DATA
4.5
4
3.5
3
2.5
INCHES 2
1.5
1
.5
0
NPC-AVERAGE NP
NPC(INCHES) P

FIGURE 3

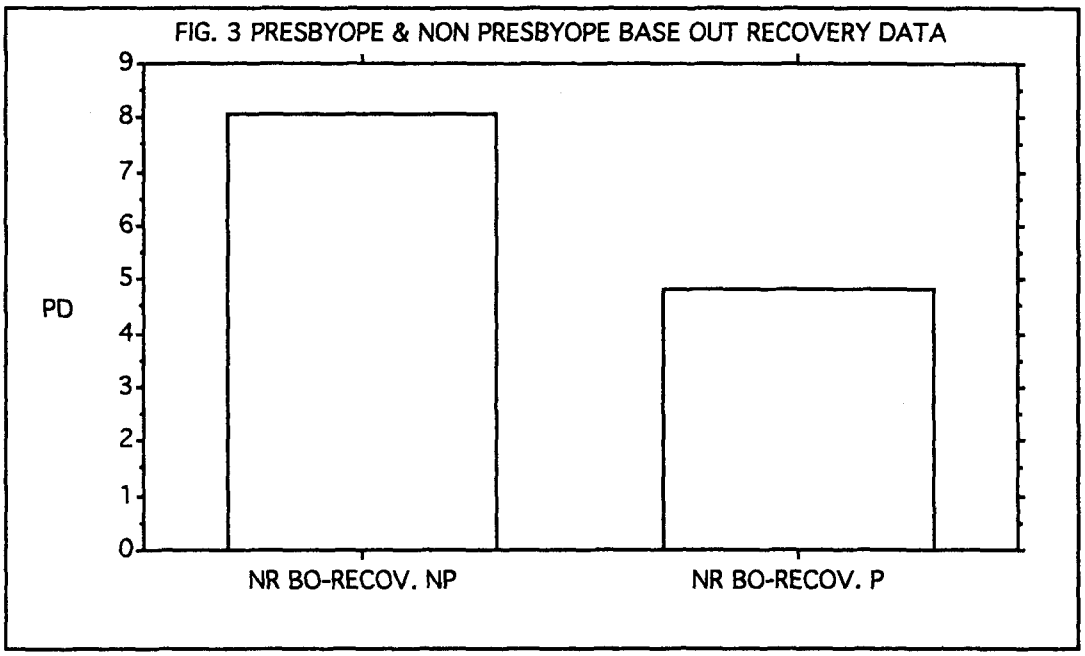


FIG. 3 PRESBYOPE & NON PRESBYOPE BASE OUT RECOVERY DATA
PD
9
8
7
6
5
4
3
2
1
0
NR BO-RECOV. NP
NR BO-RECOV. P

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