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Soft contact lenses monovision and stereopsis

Shannon M. Downey
Pacific University

Jann M. Furusho
Pacific University

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Cristina M. Schnider, O.D., F.A.A.O.

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SHANNON M. DOWNEY

JANN M. FURUSHO

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Advisor:
Cristina M. Schnider, O.D., F.A.A.O

AUTHORS:

SHANNON M. DOWNEY

JANN M. FURUSHO

ADVISOR:

CRISTINA M. SCHNIDER, O.D., F.A.A.O

Shannon Marie Downey

Born and raised in Portland, Oregon. Graduated from Wilson High School in 1983. Graduated from Southern Oregon State College in 1987 with a Bachelor of Science degree. Candidate for Doctor of Optometry degree from Pacific University College of Optometry in May, 1991. Plan to practice primary care optometry in Oregon.

Jann Miyoko Furusho

Born and raised in Honolulu, Hawaii. Graduated from Iolani School in 1984. Entered into the Freshmen Honors Program at Pacific University in the fall of 1984 and graduated with a Bachelor of Science degree in Visual Science in 1987. Candidate for Doctor of Optometry degree from Pacific University College of Optometry in May, 1991. Plan to return to Honolulu to work in a group optometric practice.

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Abstract

This investigation was structured to determine whether any of three specific measures of stereopsis improved with time following fitting with the monovision technique. Measurements were taken on nine presbyopic subjects with their habitual prescription as a baseline finding, then repeated with their monovision correction at dispensing, and at 2-day, one-week, and two-week follow-ups. While adaptation was not demonstrated there was a marked difference in performance on stereo tests based on add power. Adds below +1.75 resulted in significantly better performance than for higher adds.

Key Words: Anisometropia, stereopsis, presbyopia, monovision

Introduction

Monovision is an alternative way of correcting the presbyopic patient, where one eye is fitted for near and the other eye for distance. Most of the literature on monovision addresses the fitting technique and theories, although there also have been numerous investigations of stereopsis in the monovision patient(1-3). Monovision is the most common type of presbyopic contact lens correction primarily due to the ease in fitting(4). Wood (5) reports that the chances of success with monovision are three to five times greater than with bifocal soft lenses. In a study by Back, et.al., that compared monovision with concentric center-near lenses and a combination of center-near/center-distance concentric lenses, monovision was the most visually acceptable (6). Back's group reported a success rate of 66.7% with 117 subjects fitted with the monovision technique. Koetting (1) found that 94% of patients fitted with monovision lenses exhibited stereopsis within the norms established for their age groups. While disturbed stereopsis was not a significant subjective complaint, controversy in monovision has been around since the development of this type of fitting due to the acquired disruption of binocular vision. In a study by McGill and Erickson, et. al, reduced stereopsis in patients fitted with presbyopic contact lens options was reported compared to full binocular spectacle correction (7). McLendon et. al., reported on six patients who had a loss of stereopsis ranging from 10% to 65% (8). Sheedy, et. al (9) did a study measuring the effects on monovision with occupational task performance. One of the task performance tested

was the pointer and straw, which they found improved with time for monovision after 2 and 8 weeks. They concluded that monovision can be successful if the subject did not have critical visual needs. The dramatic induced onset of anisometropia causes some adaptation periods in the new monovision patient. McLendon, Burcham and Pheiffer (8) found that some patients reported hazy vision and occasional loss of balance during adaptation. Collins, Brown, and Bowman (10) reported poor initial near task performance for monovision wearers that improved after the first two days of wear. Other studies have found that subjective patient adaptation is not complete until two (9) or three (11) weeks of monovision wear. In other reported investigations, decreasing stereopsis with increasing presbyopia was found, but many patients reported no subjective loss of depth perception (1, 12, 13,14). This is probably due to the fact that there is more to depth perception than just stereopsis, including factors such as movement and perspective (15). Wirt (16) stated that stereopsis is relatively unimportant in operating automobiles since the relative motion of the visual field provides monocular cues to space perception. Our investigation is to determine if there is an adaptation to the loss of stereopsis when we disrupt binocularity through anisometropia.

Method

In this study a within-subjects control design was used, where each patient served as their own control. Candidates were chosen on the following criteria: presbyopic condition, no ocular conditions that would hamper successful spherical soft contact lens wear, and the motivation to wear hydrogel contact lenses. None of our subjects had ever been fitted with the monovision concept. All prospective candidates were required to have a complete eye examination and sign an informed consent document prior to being considered for the study. Thirteen subjects were initially fitted with spherical Cibasoft Visitint lenses, and nine of them completed the study. Three subjects did not complete the study due to difficulty with lens handling, and one also had difficulty in finding the most satisfying near power. The fourth person moved away to another state. Each remaining subject had a best correctable distance and near acuity of 20/20 and internal and external ocular health findings were unremarkable. Three tests used in this study are described below.

1. *The Howard-Dolman Apparatus* was used to measure distance depth perception. The subject was seated 6 meters away from the front of the Howard-Dolman Apparatus in an enclosed room to decrease any amount of environmental distraction. While the investigator had control of the single movable rod which was initially placed in a position away from the stationary rod, the subject was instructed to say,"stop" when they believed the movable rod was at the same positional level as the

stationary rod. This position was noted in centimeters from the "0" position of the stationary rod. The centimeter finding was then converted to arc seconds with the larger arc seconds being the farthest from the stationary rod while a reading of 0 arc seconds meant that the movable rod was in alignment with the stationary rod. Three readings of the Howard-Dolman were averaged to get the mean reading for each session.

2. *Pointer and Straw* was demonstrated with the subject sitting on a chair. The investigator held the straw at 40 centimeters while the subject held the pointer in their dominant hand. The patient had to place the pointer in the straw on the first attempt. The total number of successful completions was noted out of ten attempts.
3. *The Titmus Stereo Test* was done with the same conditions as the Pointer and Straw test. The subject wore polaroid glasses and was asked to identify the fly, animals, and dots until the last correct response was given and noted in arc seconds.

First, distance spherical contact lenses were fitted using the best correctable refraction found on the previous exam with changes as determined by over-refraction. Next, the dominant eye was determined by using the hole-in-the-card sighting technique. The dominant eye was fitted with the distance lens while the other eye was fitted with the near correction. The add power was determined subjectively using a trial frame at the patient's most comfortable near working distance. Our add powers ranged from +0.75 to +2.50. Once the lenses were ready to be ordered, baseline findings of the

three tests were taken using the patient's habitual correction. Six of the subjects had bifocal glasses while two required only reading glasses at near.

Following lens dispensing, our subjects were asked to wear the lenses at least eight hours a day and to be aware of any discomfort caused by the monovision concept. Ciba Vision Lensept Disinfecting System Starter Kit was given to each subject following thorough instruction on proper cleaning and disinfection, insertion, and removal. Dispensing findings for each of the three tests were taken once the contact lenses fitting evaluation was complete. Subsequent progress exams were taken at 2-day , one-week, and two-week intervals from the date of dispensing. These progress exams included any subjective reports of difficulty, any changes of visual acuities, biomicroscopy, and the three stereo tests. Data were analyzed using the Friedman test to compare differences between add powers, and the Kruskal-Wallis test to determine if there were differences in the monovision findings verses the baseline (spectacle) performance over the duration of the four visits.

Results

Our overall success rate with monovision of 69% (9/13) compared well to literature values (6). As expected, there are inherent limitations in the ability of presbyopic adults to wear contact lenses, including tear film deficiencies, visual interference from media opacities, macular changes, and other factors not directly related to the contact lenses, and handling difficulties. The latter

proved to be our biggest impediment to success, accounting for the primary reason for failure in all of the subjects unable to complete the study. In addition, two patients experienced adverse reactions related to difficulty in lens handling. The first presented to the clinic with a full quadrant subconjunctival hemorrhage due to difficulty with lens insertion. It cleared without further incident but is a rather unsightly complication which can frighten patients. The second subject experienced a significant abrasion of the inferior cornea when he repeatedly attempted to remove a lens which was no longer present. This, too, healed quickly and without serious sequellae, but caused significant discomfort for the patient during the incident.

Figures 1-3 are graphic representations of the mean findings for each subject for all contact lens visits. The baseline measurements taken with spectacles are also shown for each patient. As expected, the Howard Dolman results are the most variable, both with contact lenses and spectacles, but it is evident that there is a marked decrease in performance for the subjects with higher add powers (Figure 1 and Table 1).. However, a parallel decrease in baseline spectacle performance suggests that at least part of the effect noted was due to the subjects themselves and not the contact lenses entirely. No statistical difference in performance between patients was found using the Friedman multiple comparison test for independent samples. The most dramatic effect with higher add powers was seen with the Titmus stereofly test (Figure 2 and Table 2). It can be seen that the subjects all performed well with spectacles, but there is a precipitous drop off in performance for

adds exceeding 1.50 D. The pointer and straw task performance with monovision contact lenses was also significantly different between patients, with the patients with higher adds performing less well once again (Figure 3 and Table 3).

Tables 4, 5 and 6 show statistical analyses of the data for each of the tests compared across visits using the Kruskal-Wallis test for correlated samples. As anticipated, there was no significant change over time, indicating a lack of adaptation on all tests performed.

Howard Dolman Results

Friedman 9 X variables

DF	8
# Samples	9
# Cases	4
Chi_r-Squared	10.317 p=0.2435
Chi corrected for ties	10.514 p=0.2308
# tied groups	6

Note: 2 cases deleted with missing values.

1

Friedman 9 X variables

Name:	Σ Rank:	Mean Rank:
hd1	10.5	2.625
hd2	23.5	5.875
hd3	15.5	3.875
h4	23	5.75
h5	21.5	5.375

2

Friedman 9 X variables

Name:	Σ Rank:	Mean Rank:
h6	29.5	7.375
h7	23	5.75
h8	22	5.5
h9	11.5	2.875

3

Table 1 - Friedman Analysis by patient/add

Titmus Stereofly Results

Friedman 9 X variables

DF	8
# Samples	9
# Cases	4
Chi_r-Squared	22.35 p=0.0043
Chi corrected for ties	24.382 p=0.002
# tied groups	10

Note: 2 cases deleted with missing values.

1

Friedman 9 X variables

Name:	Σ Rank:	Mean Rank:
tm1	9.5	2.375
tit2	12.5	3.125
t3	20.5	5.125
t4	12	3
t5	13	3.25

2

Friedman 9 X variables

Name:	Σ Rank:	Mean Rank:
t6	30	7.5
t7	32.5	8.125
t8	31.5	7.875
t9	18.5	4.625

3

TABLE 2 - Friedman Analysis by patient/add

Pointer & Straw Results

Friedman 9 X variables

DF	8
# Samples	9
# Cases	4
Chi_r-Squared	15.967 p=0.0429
Chi corrected for ties	16.625 p=0.0343
# tied groups	13

Note: 2 cases deleted with missing values.

1

Friedman 9 X variables

Name:	Σ Rank:	Mean Rank:
ps1	29.5	7.375
ps2	22	5.5
p3	22	5.5
p4	25.5	6.375
p5	16.5	4.125

2

Friedman 9 X variables

Name:	Σ Rank:	Mean Rank:
p6	17	4.25
p7	15	3.75
p8	4.5	1.125
p9	28	7

3

Table 3 - Friedman Analysis by patient/add

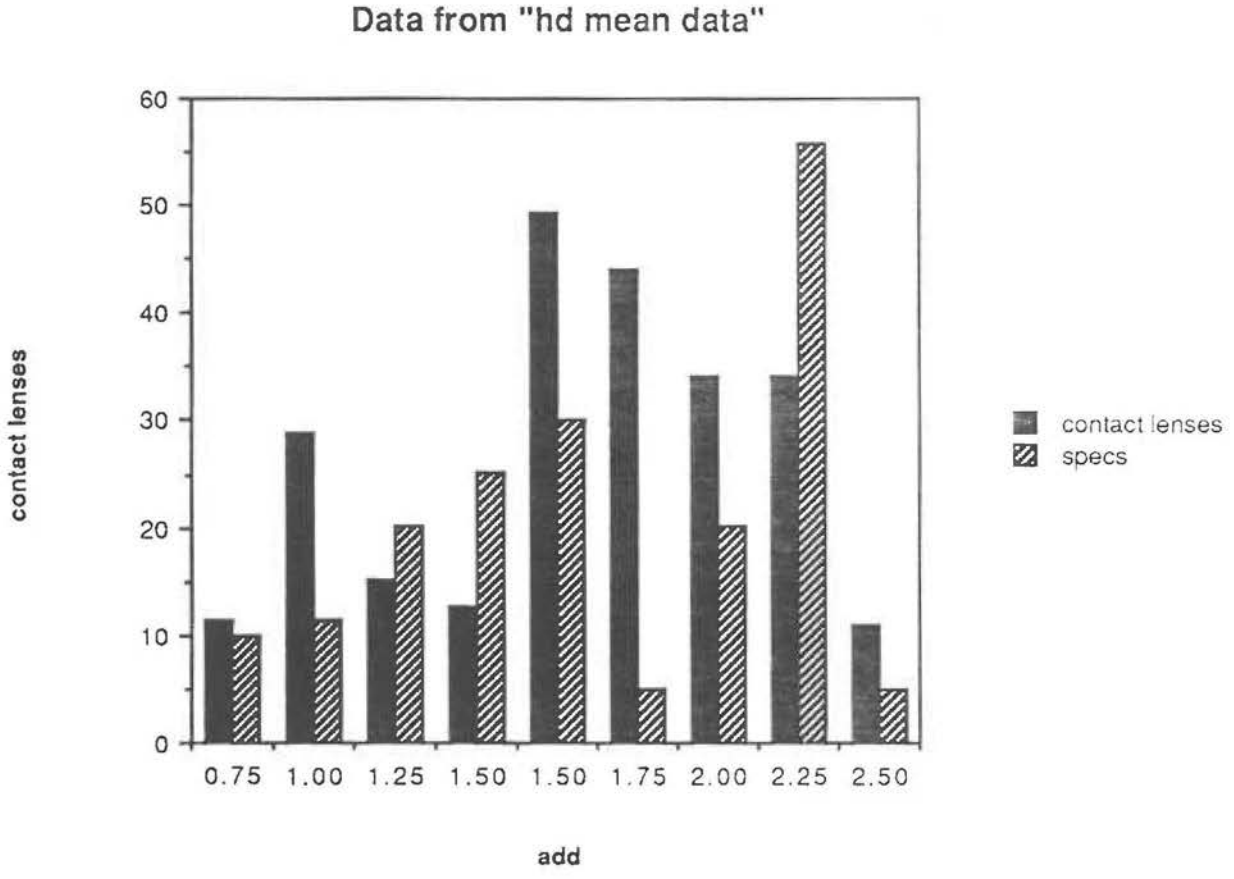

Figure 1. Results by patient per add power
Howard-Dolman

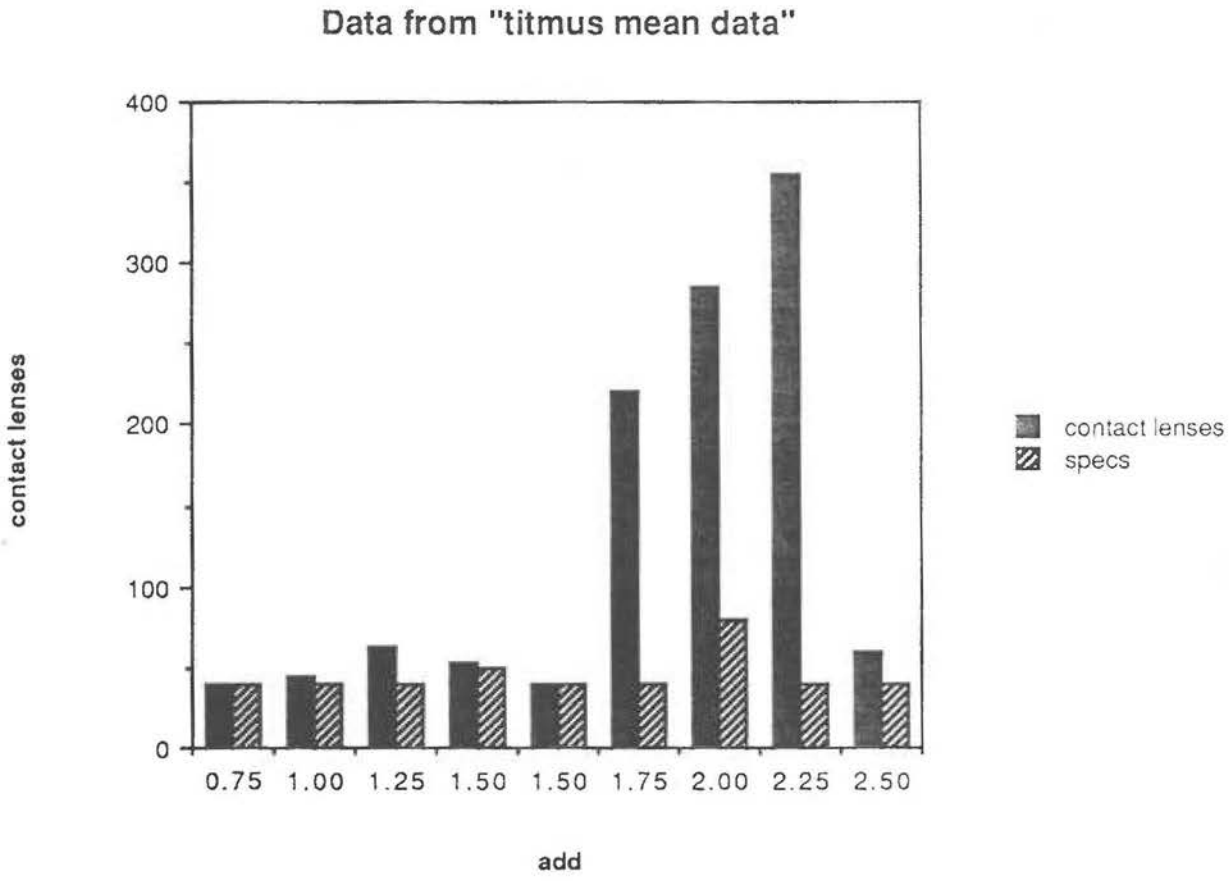

Figure 2. Results by patient per add power
Titmus Stereofly

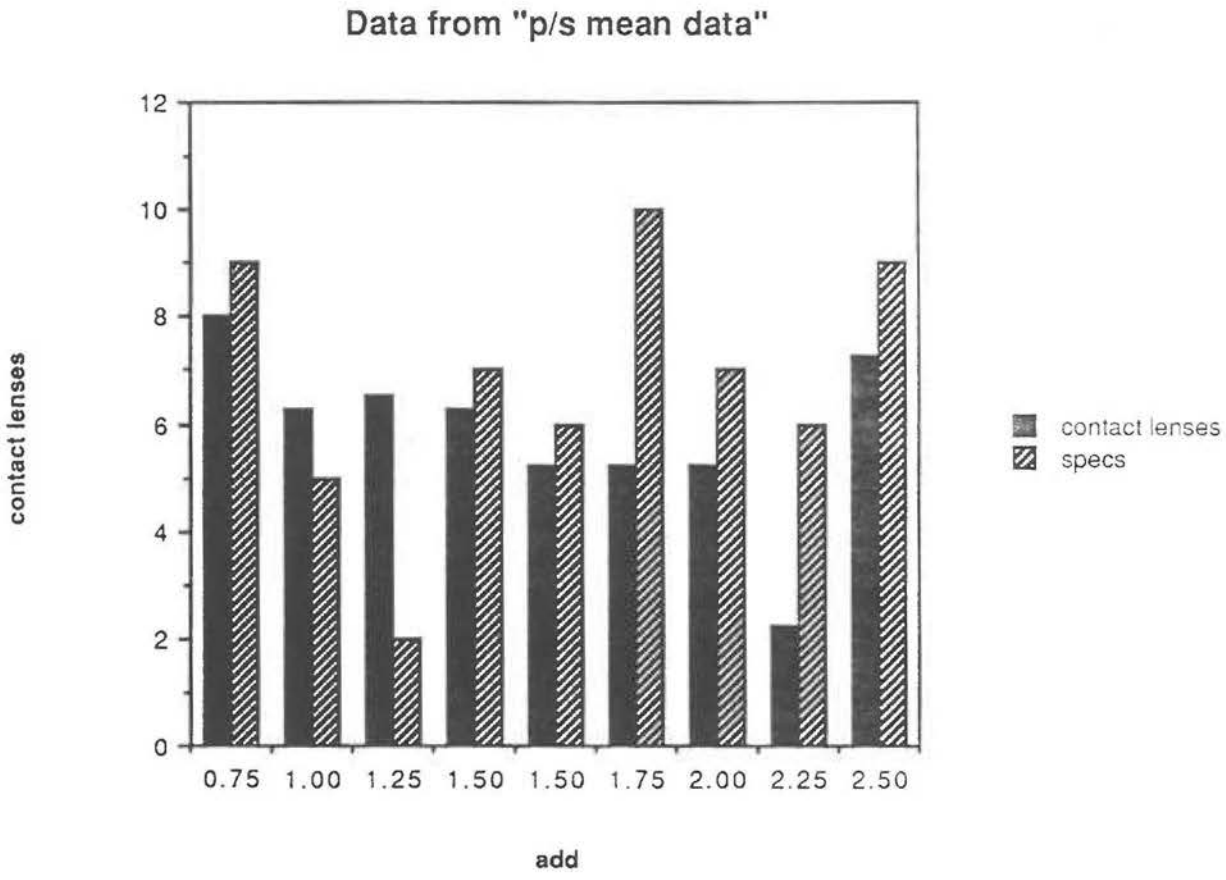

Figure 3. Results by patient per add power
Pointer and Straw

Kruskal-Wallis X 1 : VISIT Y 1 : HD

DF	3	
# Groups	4	
# Cases	36	
H	.945	p = .8146
H corrected for ties	.952	p = .8128
# tied groups	7	

Kruskal-Wallis X 1 : VISIT Y 1 : HD

Group:	# Cases:	Σ Rank:	Mean Rank:
Group 1	9	148.5	-.02
Group 2	9	156.5	-.021
Group 3	9	188.5	-.026
Group 4	9	172.5	-.023

Group	Visit
1	Dispense
2	2-day follow-up
3	one week follow-up
4	two week follow-up

Figure 4: Kruskal-Wallis results by visit for Howard Dolman

Kruskal-Wallis X 1 : VISIT Y 3 : STEREOFLY

DF	3	
# Groups	4	
# Cases	36	
H	.294	p = .9612
H corrected for ties	.318	p = .9566
# tied groups	7	

Kruskal-Wallis X 1 : VISIT Y 3 : STEREOFLY

Group:	# Cases:	Σ Rank:	Mean Rank:
Group 1	9	175	-.024
Group 2	9	161.5	-.022
Group 3	9	155	-.021
Group 4	9	174.5	-.024

Group	Visit
1	Dispense
2	2-day follow-up
3	one week follow-up
4	two week follow-up

Figure 5: Kruskal-Wallis results by visit for Titmus Stereofly

Kruskal-Wallis X_1 : VISIT Y_2 : P/S

DF	3	
# Groups	4	
# Cases	36	
H	3.122	p = .3733
H corrected for ties	3.206	p = .361
# tied groups	7	

Kruskal-Wallis X_1 : VISIT Y_2 : P/S

Group:	# Cases:	Σ Rank:	Mean Rank:
Group 1	9	142.5	-.019
Group 2	9	157	-.021
Group 3	9	214	-.029
Group 4	9	152.5	-.021

Group	Visit
1	Dispense
2	2-day follow-up
3	one week follow-up
4	two week follow-up

Figure 6: Kruskal-Wallis results by visit for Pointer-Straw

Discussion

Although our investigation showed that there is a difference between the higher add powers and the lower add powers for subjects' performance on the Howard-Dolman and Titmus Stereofly tests, there is no evidence that the subjects actually adapted to the loss in stereopsis. As with previous studies, this study demonstrated a large variation in patient response, which was not entirely consistent with age or add power. In fact, our only subject with a +2.50 add performed as well or better than the subjects with the lowest adds. For this reason, the subject numbers in this study were unacceptably low, and limit the conclusions which can be drawn and generalized to the presbyopic patient at large. However, our data were in agreement with a number of patient studies with regards to success rates and stereo test results.

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