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## The effect of add power on distance vision with Acuvue bifocal contact lenses

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# The effect of add power on distance vision with Acuvue bifocal contact lenses

## Abstract

This study was designed to determine if subjective evaluation of quality of vision could be correlated with reduction in high and low contrast acuity scores. LogMAR visual acuities of 20 non-presbyopic subjects were measured using high and low-contrast Bailey- Lovie charts. Each subject wore an Acuvue Bifocal contact lens with add powers +1.00, +1.50, +2.00, and +2.50, each optimized for best distance acuity. Subjects showed significantly decreased acuities with increasing add; a low-contrast target heightened this effect. Subjects reported a reduction in quality of distance vision, increasing fluctuation, ghosting/shadows, and halos around lights that correlated with increasing add power. Our findings suggest that the Acuvue Bifocal contact lens may be expected to perform best for low-to-moderate presbyopes, and that clinicians should anticipate decreased low contrast acuity and reduced overall quality of vision as add powers are increased.

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## Degree Name

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Peter Bergenske

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**The Effect of Add Power on Distance Vision  
with the Acuvue Bifocal Contact Lens**

BY:

David Ardaya, Giulia DeVuono, Ivy Lin, and

Annie Neutgens

A thesis submitted to the faculty of the  
College of Optometry  
Pacific University  
Forest Grove, OR  
For the degree of  
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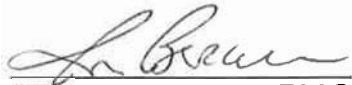
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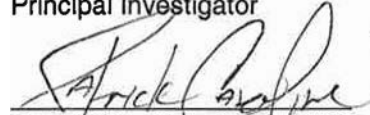
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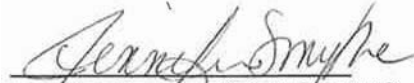
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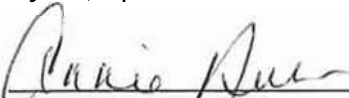


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## **ABOUT THE AUTHORS**

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Dave was born in Santa Cruz, Bolivia. He was raised in Phoenix, AZ, and graduated from the University of Arizona with a B.S. in Physiological Sciences in 1998. He wants to sell his soul to corporate optometry after he graduates or open a private practice near a beach.

### **DeVuono, Giulia**

Giulia was born and raised in Trail, British Columbia, Canada. She graduated from the University of British Columbia with a B.S. in Animal Biology. Giulia is currently involved in Beta Sigma Kappa Optometric Honor Society and Amigos Eye Care. Upon graduation in May 2003, she plans to return to Canada and practice optometry.

### **Lin, Ivy**

Ivy was born in Anaheim, CA, and grew up in Orange County. She graduated from UCLA with a B.S. in Psychobiology. Her goals include returning to Southern California to practice optometry in a private multidisciplinary setting (and owning a llama).

### **Neutgens, Annie**

Annie was born in Baker, MT, and raised in Wolf Point, MT. She graduated from Montana State University-Bozeman with a B.S. in Biology in 1999. She plans to return to the Rockies to practice optometry upon graduation in May 2003.

## **Abstract**

This study was designed to determine if subjective evaluation of quality of vision could be correlated with reduction in high and low contrast acuity scores. LogMAR visual acuities of 20 non-presbyopic subjects were measured using high and low-contrast Bailey-Lovie charts. Each subject wore an Acuvue Bifocal contact lens with add powers +1.00, +1.50, +2.00, and +2.50, each optimized for best distance acuity. Subjects showed significantly decreased acuities with increasing add; a low-contrast target heightened this effect. Subjects reported a reduction in quality of distance vision, increasing fluctuation, ghosting/shadows, and halos around lights that correlated with increasing add power. Our findings suggest that the Acuvue Bifocal contact lens may be expected to perform best for low-to-moderate presbyopes, and that clinicians should anticipate decreased low contrast acuity and reduced overall quality of vision as add powers are increased.

## **Acknowledgements**

We would like to thank everyone that made our thesis study a success. Dr. Peter Bergenske, Dr. Jennifer Smythe, and Pat Caroline were there for guidance and support since the beginning of our project. From the planning and consulting to the last minute finishing tasks, they were there. It was great to work with and have input from clinicians so well respected in their field.

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One last thanks goes to our study participants. Thank you for your time and consideration in helping our thesis project.

## Introduction

With four million Americans becoming presbyopic every year, the demand for multifocal contact lenses is at an all-time high<sup>1</sup>. In fact, the year 2000 saw contact lens wear among 40 to 64-year-olds surpass all other age groups<sup>2</sup>. In response to the increased demand, various multifocal lens designs have been developed: diffractive, concentric, aspheric, and translating, among others. One of the most frequently prescribed bifocal contact lenses is the Acuvue Bifocal, a soft hydrophilic lens with a concentric multi-zone design that allows for simultaneous distance and near viewing.

Although the literature reports varying success rates for multifocal contact lenses, a recent study reported a 53% success rate with the Acuvue Bifocal<sup>3</sup>. The simultaneous correction of distance and near vision, while convenient, gives rise to decreases in visual acuity, contrast sensitivity, and increased complaints of halos and glare. More specifically, it has been clinically observed that patient satisfaction is compromised as the add power increases. Although generally accepted, limited attempts have been made to quantify this effect. As the balance between distance and near vision is critical for a successful bifocal contact lens fit, an estimate of predicted reduction in distance vision with increasing add power would be beneficial to clinicians. The purpose of this study was to demonstrate the effect of add power on the distance visual acuity at varying contrasts, both objectively and subjectively.

It is important to note that our findings were obtained with non-presbyopic subjects so that no senile ocular changes would affect the findings. Also, since this study analyzed the effects of increasing add power on distance vision, the effects of accommodation were negated.



## **METHODS**

### **Subjects**

Twenty optometric students between the ages of 23 and 31, all current soft contact lens wearers, served as subjects for our study. All subjects had less than 0.75D of astigmatism and their refractive errors fell within the available parameters of the Acuvue Bifocal lens. All subjects had a complete eye exam within the last 12 months and were deemed free of ocular or systemic conditions which would contraindicate contact lens wear.

In order to be eligible, subjects were required to achieve distance visual acuities of 20/20 or better with 1-Day Acuvue soft contact lenses. All subjects were myopic, with refractive errors ranging from  $-0.75$  to  $-5.50$ . Prior to participation in the study, each subject was required to provide written consent.

### **Design**

All trials in this study were performed monocularly. An over-refraction of the patient's habitual lenses provided his/her initial correction for the test lenses. The fit of the 1-day Acuvue was assessed after 10 minutes of equilibration, after which high and low-contrast distance visual acuities were measured with a standard Bailey-Lovie chart at twenty feet under standard room illumination. These conditions were constant for all trials.

The same procedure was followed for the bifocal lenses. Subjects were fit and evaluated with each Acuvue Bifocal (+1.00, +1.50, +2.00, and +2.50 adds) in a randomized, double-blind fashion. To assure that no lenses were worn inside-out, an examiner viewed the inversion marks on each lens with the biomicroscope prior to equilibration and testing. After equilibration, high contrast visual acuities were taken. If a

-0.25D lens improved high contrast visual acuity by 2 or more letters, a new lens was dispensed in the new power and allowed to equilibrate. Thus, high contrast distance acuity was optimized for each add power prior to final acuity measures. This protocol adheres to the Acuvue Bifocal fitting guide, and most closely resembles clinical practice. Low contrast visual acuities were then measured through the optimized lens, or the original lens if no change was indicated. In addition, subjects were required to complete questionnaires regarding the visual quality of each optimized lens. Subjects were asked to rate characteristics of the lenses, such as handling, comfort, overall vision, fluctuation of vision, **ghosting/haloes**, etc on a scale of 1-50 (with 50 being ideal).

## **Materials**

The 1-Day Acuvue lens was selected for baseline measures because it shares similar features with the Acuvue bifocal, such as the 8.5 mm base curve and a 14.2 mm diameter. The 1-Day Acuvue is a spherical, single vision soft contact lens, available in powers ranging from +6.00D to -12.00D. The Acuvue Bifocal is a concentric center distance design with five alternating zones. It also has an inversion indicator of "1 2 3" on the front surface. The Acuvue Bifocal is available from +6.00D to -9.00D with add powers of +1.00, +1.50, +2.00, and +2.50. Both lenses are made of etafilcon A, with 58% water content and dK of 28.0.

## **Results**

Measures of **logMAR** acuities showed highly statistically significant differences across all viewing conditions, as shown in Table 1. Differences in mean monocular **logMAR** acuities were significant between the standard 1-day Acuvue and each of the four bifocal powers (repeated-measures ANOVA, N=20,  $p < 0.000$ ). In addition, differences were significant among lenses of the same power between high and low contrast levels

(N=20, p<0.000). Figure 1 shows the linear decrement in Snellen acuity as add power increases for both contrast levels.

Statistically significant differences were found for four of the six subjective measures. The two that showed no statistical significance were overall comfort and overall handling, as anticipated. However, subjects' ratings of distance vision, fluctuating vision, ghosting/shadows, and halos around lights indicated a significant decline in subjective assessment of quality of vision as add power increased (p<0.000). Figure 2 provides a summary of the mean subjective ratings.

## Discussion

With an ever-growing number of the population becoming presbyopic, it is increasingly important for the clinician to successfully fit bifocal contact lenses. While many patients may favor contact lenses for their convenience and cosmesis, proper patient selection/screening is essential for wearing success. Clinically, it is common knowledge that compared to a spectacle correction, both visual performance and task performance are often compromised with simultaneous vision contact lenses<sup>4,5,6,7</sup>. Our study measured both the quality of vision and visual acuity for increasing add powers when compared to a standard single-vision lens.

Distance vision, fluctuating vision, ghosting/shadows, and halos around lights were all rated lower as add power increased. Subjective assessment of quality of distance vision showed the greatest decline from a mean rating of 39 (1-day Acuvue) to 19.6 (+2.50 add).

Our objective findings validated the patients' subjective assessments. Compared to the acuity achieved with the 1-day Acuvue, subjects experienced a reduction in distance acuity of 0.7 to 2.3 logMAR lines under high-contrast conditions with the

Acuvue Bifocal. The decrease in distance acuity was amplified when tested with low-contrast lettering. The low-contrast distance acuity reduction ranged from 1.3 to 3.6 lines.

It is important to note that our findings were obtained with non-presbyopic subjects. Age-related changes in the eyes, most notably cataracts, would decrease contrast sensitivity even further, possibly leading to more visual complaints<sup>6,8</sup>. Clinicians should be aware that distance vision appears to worsen in simulated nighttime conditions<sup>a5</sup>. We confirmed that low contrast conditions exaggerate effect on both acuity and subjective perception of vision quality.

Our study used monocular measures; one would expect superior visual acuities in a clinical setting due to binocularity<sup>4</sup>. Benefits of a simultaneous vision contact lens include stereopsis similar to that with a spectacle correction<sup>7</sup>, and better stereopsis and near task performance than with monovision or modified monovision<sup>9</sup>. One study found that after 8 weeks of adaptation, presbyopic patients showed improved near task performance despite unchanged acuities and stereopsis<sup>10</sup>. Therefore, it seems that with time, patients can better learn to function with their reduced acuity. Our subjects were not presbyopic and were only allowed a minimal adaptation time. Results with adapted presbyopic subjects would need to be determined to further explore the effects we found.

Despite the subjective and objective decreases in visual performance, the Acuvue Bifocal contact lens provides the clinician with a much needed option for presbyopes. Success rates are dependent on proper patient selection and patient motivation. Doctors have reported a 20 percent increase in satisfaction rate with the lens after modifying patient selection criteria<sup>i2</sup>. Higher fitting success rates may be accomplished if the following ideas are taken into account:

1. Visual acuity decreases with increasing add power; therefore, patients requiring or tolerating a lower add power may be more satisfied with these lenses.

2. Visual acuity will show an even greater decrease with low-contrast targets or in dim illumination; therefore, an older **presbyope's** visual system may be compromised more than that of a younger presbyope.
3. Fluctuating vision, ghosting, and halos are all significantly correlated with increasing add power; therefore, educating the patient that these are normal side effects associated with the lens may increase acceptance.

Combined with its large range of available powers, comfort and handling, and minimal chair time, the Acuvue bifocal lens should prove to be a valuable tool and asset for any practice.

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<b>Snellen Denominator Values</b>						
		<b>1-Day Acuvue</b>	<b>+1.00 Add</b>	<b>+1.50 Add</b>	<b>+2.00 Add</b>	<b>+2.50 Add</b>
<b>High Contrast</b>	<b>Mean</b>	17.54	20.66	22.75	26.37	29.51
	<b>s.d.</b>	3.41	4.85	4.34	6.61	6.06
<b>Low Contrast</b>	<b>Mean</b>	26.49	35.65	44.16	48.09	60.68
	<b>s.d.</b>	3.74	6.92	8.84	6.88	6.93

Table 1. Mean Snellen denominator values.



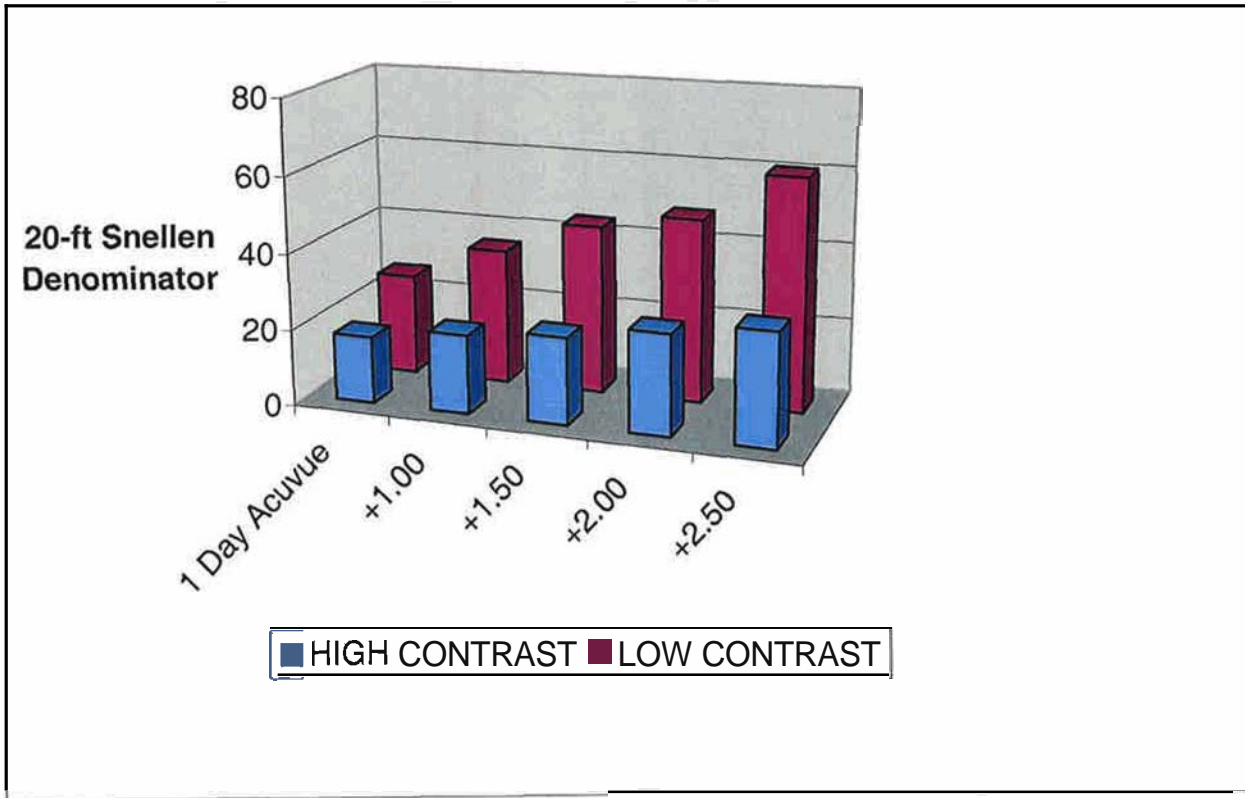


Figure 1. Decrease in Snellen acuity with increased add power.

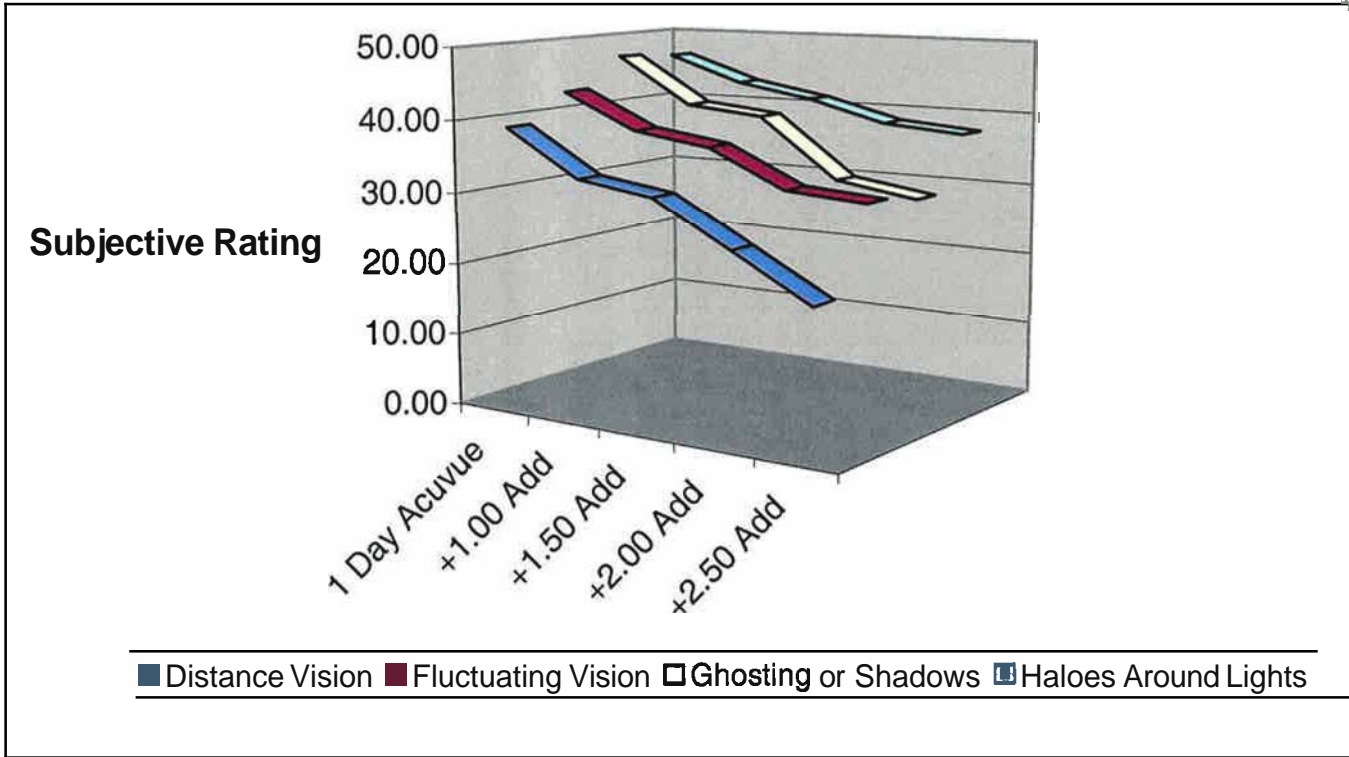


Figure 2. Decrease in subjective rating of quality of vision with increasing add power