EVALUATING TINTED LENS PREFERENCES IN PATIENTS WITH VISUAL IMPAIRMENT

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ABSTRACT

*Background***:** Many visually impaired patients prefer tinted lenses demonstrated during a low vision examination to improve visual quality/function. In most low vision rehabilitation examinations, the patient is able to sample tint colors before coming to a conclusion about which is most effective. It is unclear whether a correlation in color preference exists among patients with the same disease. The goal of this research is to subjectively determine which tints work best for patients with specific visually compromising diseases for indoor and outdoor use. *Methods***:** The sample size was 16 and all were visually impaired. The subjects were asked to trial tinted glasses of the same shape, size, and brand while observing reading material and ranked the top two choices that improved reading ability. To assess outdoor tints, the subjects were asked to trial the tinted glasses in front of an assigned window and ranked the top two choices that improved visual quality. The weather and time of day were ranked on a set scale. *Results***:** The overall results for indoor tints were not clinically significant (P=0.5676, H=7.671). None of the disease categories showed statistical significance on their own with regards to indoor tints. In the overall assessment of outdoor tints, the results were considered statistically significant (P=0.0014, H=28.65). Stargardt disease and age-related macular degeneration were deemed statistically significant whereas all other diseases did not yield significant results. Weather patterns were not taken into account due to an insufficient sample size. *Conclusions*: The results of this research conclude that

no inferences can be made at this time regarding the relationship between disease and indoor tint preferences. Statistical analyses for the use of outdoor tints were deemed significant and more specific tints may be recommended based on the patient's disease.

Keywords: Colored filters, low vision, tints, tinted lenses, visual rehabilitation

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CHAPTER 1

INTRODUCTION OF EVALUATING TINTED LENS PREFERENCES IN PATIENTS WITH VISUAL IMPAIRMENT

Many progressive eye diseases are the source of reduced contrast sensitivity and visual acuity, making activities of daily living quite challenging. In such cases, tinted lenses are commonly trialed by a low vision specialist where the patient is free to choose which colored tint he/she prefers, if any. Many low vision patients experience a perceived benefit when trialing certain colored tints as they may reduce glare and/or light sensitivity, while others claim the tints provide no benefit.[1,2] According to a study conducted in 2013, different tints and their grades affect spatial frequencies differently. This study concluded that lighter tints improve contrast sensitivity at high spatial frequencies and darker tints improve contrast sensitivity at low spatial frequencies, revealing an inverse relationship. Therefore, various tasks may require different tints for the same patients.[3] Reading material simulating that used in daily life may be used to allow tint comparisons during an indoor trial. For the selection of an outdoor tint, the patient may be instructed to trial the lenses through a window or outdoors, although changing weather patterns may influence the patient's perception and/or decision.

The status of one's cataract may also be pertinent to determining tint preference. A study published in the Journal of Ophthalmic and Vision Research in 2011 determined that an increase in cataract severity strongly correlates with a decrease in both visual

acuity and contrast sensitivity. Thus, assessing the status of the patient's contrast sensitivity may allow for better tint suggestions from the practitioner.[4]

Several studies have been conducted to evaluate the benefits of tinted lenses when used in sports or as a treatment for dyslexia and other reading disorders. The effect on contrast sensitivity among youth hockey players wearing amber tinted lenses was evaluated by the optometry department at the University of Technology in Malaysia. This study proved a statistically significant enhancement in contrast sensitivity when using an amber tinted lens. However, this study was conducted on children with the absence of any ocular pathology/impairments.[5]

The benefits of tinted lenses in those with dyslexia are also inconsistent among various studies. A study from the journal of Investigative Ophthalmology and Vision Science tested the effect of tinted lenses on spatiotemporal visual function in children who experienced perceptual distortions while reading. The results did not objectively reveal any significant differences in visual function with the use of tinted lenses and did not evaluate the presence of any perceived benefits by the subjects.[6] The American Optometric Association (AOA) provides a comprehensive discussion of similar studies which evaluate the use of tinted lenses in those with reading disabilities and discloses conflicting results among the varying studies. One study in particular demonstrates improved eye movements when reading through blue filters, although no improvement in comprehension scores were demonstrated.[7-9] However, there is also no evidence to suggest that any reading improvements in patients with dyslexia/reading disabilities will also improve reading for visually impaired patients.

Few studies have evaluated the efficacy of tinted lenses in low vision patients. In the limited studies that exist, results were commonly inconclusive and objective measures typically conflicted with the patient's subjective opinion. A 2013 study involving the use of indoor and outdoor tints in patients with age-related macular degeneration (AMD) concluded that almost 50% of subjects preferred amber colored tints. However, this did not cause a significant change in visual acuity or contrast sensitivity and this study failed to take into account the changes in weather patterns and/or time of day.[10] Other studies show more significant improvements in visual acuity and contrast sensitivity with the use of tints in those with AMD but have not developed a color schematic to assist in prescribing them.[11]

Evaluating the use of tints in patients with glaucoma could also show discrepancies depending on the severity of the disease. A 2014 study determined that a clinically significant color vision deficiency exists to a variable extent depending on the stage of the patient's glaucoma. These color vision deficiencies directly correlated with an increased severity of the disease. Therefore, differences in acquired color vision deficiencies may influence each subject's preferred tint selections differently, depending on whether the subject has early versus late stage glaucoma.[12]

Other studies have concluded that colored filters caused a decrease in retinal illuminance, also reducing visual acuity and contrast sensitivity, while some studies demonstrate the opposite relationship.[2,13] Adequate research regarding a systematic use of tinted lenses according to disease is currently lacking.

The goal of this study is to utilize patient subjective tint selection to indicate whether a correlation between specific diseases and colored tints exists, both indoors and outdoors while also accounting for weather patterns. If a correlation does exist, eye care practitioners will be able to make more credible, research-based recommendations to their low vision patients.

CHAPTER 2

METHODS OF EVALUATING TINTED LENS PREFERENCES IN PATIENTS WITH VISUAL IMPAIRMENT

All patients recruited for the study were scheduled for a low vision examination in the Vision Rehabilitation Service at the Ferris State University Eye Center in Big Rapids, Michigan, between January 2015 and April 2015. All patients were visually impaired with a diagnosed visually compromising eye disease, such as age-related macular degeneration (AMD), diabetic retinopathy, glaucoma, albinism, retinitis pigmentosa (RP), Stargardt disease, optic nerve hypoplasia, optic neuritis, idiopathic intracranial hypertension, stroke, and macular hole. Patients ages 16 and older were invited to participate as long as they met the visual impairment requirement and were deemed cognitively able to complete the study. The inclusion criteria for the purposes of this study were defined as a best corrected distance visual acuity of 20/40 or worse and/or a remaining horizontal visual field of 100 degrees or less in both eyes and/or a minimum of 25% reduction in contrast sensitivity. All procedures used in this study are common parts of a complete low vision examination and were approved by Ferris State University's Institutional Review Board. Patients were given an informational sheet regarding the study and were given the option to decline participation. Verbal consent to collect data for the sake of this study was obtained from every participant. Patients with inherited color vision deficiencies or significant cognitive deficits were excluded from this study.

Subjects were asked to trial a pre-selected sample of tints supplied by NoIR Medical Technologies©. The colors were selected based on popularity using the researchers' clinical experience. All tints are of the same size, shape, and brand, and were trialed in random order. For a complete list of sampled tints trialed in this study see page 20. The data is separated into an indoor segment and an outdoor segment, and then sub-categorized by disease.

To evaluate indoor tint preferences, subjects were taken to a specific room in the clinic with consistent lighting. The subjects were asked to trial the sample tints over their best corrected spectacle or contact lens prescription while observing reading material. The subjects were then asked to rank their top two choices based on which best improved their near visual function. Choosing a tint was not required if the subject did not perceive an improvement. No objective data such as visual acuity, color vision, or contrast sensitivity was collected during the tint assessment. The data collected during this segment includes age, sex, primary disease causing vision loss, and the subject's top two indoor rankings. In the instance of two diseases which cumulatively caused a subject's vision loss, only the disease deemed the primary cause of vision loss was included.

To evaluate outdoor tint preferences, subjects were taken to an assigned window inside the clinic. The subjects were asked to trial the sample tints while observing the outdoors and were again asked to rank their top two choices for enhancing visual function, if applicable. Subjects were not required to choose a tint if they did not perceive an improvement. Outdoor tint assessments were only conducted during daylight hours. The weather at the time of trialing was ranked on a set scale where 1= rain/overcast and

10 = sunny/no clouds. The data collected during this segment included age, sex, primary disease causing vision loss, the subject's top two outdoor rankings, and the weather scale.

Table 1

Percent Transmission/Color

Indoor Tints	Outdoor Tints
40% light red	30% blue
53% light amber	10% grey-green
52% light orange	10% amber
14% yellow	2% amber
54% yellow	40% grey-green
30% blue	16% amber
50% light green	39% dark red/orange
40% plum	32% medium grey
58% light grey	4% plum
4% dark yellow	4% dark amber
	13% dark grey

CHAPTER 3

RESULTS OF EVALUATING TINTED LENS PREFERENCES IN PATIENTS WITH VISUAL IMPAIRMENT

The sample size consisted of 16 patients, of which 7 were male and 9 were female. The ages ranged from 19 to 92 years old and the average age of patients was 54.6 years old. The subjects were categorized by disease; glaucoma, AMD, RP, ocular albinism, diabetic retinopathy, optic nerve hypoplasia, Stargardt disease, optic neuritis, idiopathic intracranial hypertension (IIH), stroke, and macular hole. The Kruskal-Wallis test was used to determine that the overall results for indoor tints were not deemed clinically significant (P=0.5676, H=7.671). Based on the disease-specific analysis using the ANOVA test, none of the disease categories showed statistical significance. Of the subjects with AMD, diabetic retinopathy, Stargardt disease, RP or optic neuritis, different tints were always preferred among the same disease category (See Table 2 below for disease-specific P-values). The rest of the disease categories only included data for a single subject and statistical significance could not be determined. Statistical analysis based on age and sex of the subjects was not performed due to an insufficient sample size.

Table 2:

Indoor Tint Assessment by Disease (Ordinary One-Way ANOVA Test)

Disease	P-value	F
AMD	0.6245	0.8025
DM	0.6245	0.8025
Stargardt Disease	0.6245	0.8025
RP	0.5654	0.8889
Optic Neuritis	0.6245	0.8025

In the overall assessment of outdoor tints, the Kruskal-Wallis test was used to determine that the results were considered statistically significant (P=0.0014, H=28.65). Based on the disease-specific analysis using the ANOVA test, the results for Stargardt disease and AMD were deemed clinically significant, while RP, diabetic retinopathy, and optic neuritis were not (See Table 3 below for disease-specific P-values). Subjects with Stargardt disease showed a tint preference for the 30% blue and those with AMD showed a preference for both 40% grey/green and 16% amber. Again, the rest of the disease categories only included data for a single subject and statistical significance could not be determined. Statistical analysis based on weather patterns and the age/sex of the subjects was not performed due to an insufficient sample size. Since this research was administered in the state of Michigan during the winter and early spring months, there was little variability in the weather pattern and it was not accounted for in this statistical analysis.

Table 3:

Outdoor Tint Assessment by Disease (Ordinary One-Way ANOVA Test)

Disease	P-value	F
AMD	0.0009	8.100
DM	0.1413	1.967
Stargardt Disease	0.0001	16.20
RP	0.1413	1.967
Optic Neuritis	0.6786	0.7400

CHAPTER 4

DISCUSSION OF EVALUATING TINTED LENS PREFERENCES IN PATIENTS WITH VISUAL IMPAIRMENT

The results of the indoor segment of this study were inconclusive. No disease category showed any statistical significance on its own. This is likely due to the insufficient number of subjects in the sample size and our inability to run statistical analyses on the diseases consisting of only one subject. The 40% plum and the 50% light green tint were the most popular overall. Disease-based statistical analysis was not conducted in those with albinism, stroke, macular hole, glaucoma, or IIH due to insufficient data accumulation. No inferences can be made at this time regarding whether a correlation between disease and indoor tint preferences exist among patients with visual impairment.

The results of the outdoor segment of this study showed overall statistical significance which was mostly drawn from the AMD and Stargardt disease categories. Subjects with AMD preferred 16% amber and 40% grey/green, which were also the most popular overall and the most popular among subjects with RP. Subjects with Stargardt disease showed a preference for the 30% blue tint and exhibited the strongest correlation to a tint relative to all the other diseases. Although the statistics yielded significance for AMD and Stargardt disease, the sample size for each of these diseases was only based on data collected from two subjects per category. Tint preferences for subjects with diabetic

retinopathy, RP, and optic neuritis did not show any statistical correlation with the disease. Disease-based statistical analysis was not conducted in those with albinism, stroke, macular hole, glaucoma, or IIH due to insufficient data accumulation.

Several limitations which may have influenced the results of this study exist. One possible flaw is that the crystalline lens status of these subjects was not taken into account. Subjects in the same disease category who had visually significant cataracts may have chosen differently from those who were pseudophakic due to the changes in contrast sensitivity or increased glare. Furthermore, an analysis incorporating the age of the subjects may also be pertinent as younger subjects are less likely to be affected by cataracts. Since it would be more time consuming to allow each subject to trial every color tint, the tints to trial were selected by the researchers' experience based on popularity. However, popularity may vary depending on geographical location, weather patterns, and patient base. Additionally, the effect of weather on outdoor tint preferences may influence the subjects' rankings and will be accounted for in ongoing research.

A greater sample size is ultimately needed to construct more reliable inferences on statistically significant tint preferences. The analysis displayed in this research is based on a sample size of only 16 subjects thus far. Ongoing research is expected to take place in the low vision clinic at the Battle Creek Veterans Affairs Medical Center throughout the rest of the 2015 calendar year. Our future goals for this research include determining whether or not correlations are affected by the age or sex of the subjects and to also account for changes in weather patterns. It will be interesting to see whether the relationship for outdoor tints regarding AMD and Stargardt disease strengthen or dissipate, and whether any other associations emerge. If the future results of this project

conclude a correlation exists upon further statistical analysis, then a specific tint can be recommended based on a patient's disease. This will not only save time during the examination, but will also promote a wider acceptance in the use of tinted lenses among low vision clinicians.

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To: Dr. Sarah Hinkley, Dr. Matthew Johnson and Christine Mekhayel
From: Dr. Stephanie Thomson, IRB Chair
Re: IRB Application #140504 (*Evaluating Tinted Lens Preferences in Patients with Vision Impairment)*
Date: December 23, 2014

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, "*Evaluating Tinted Lens Preferences in Patients with Vision Impairment*" (#140504) and has determined that it meets Federal Regulation category, *Expedited –category 2D*. This approval has an expiration date of one year from the date of this letter. **As such, you may collect data according to procedures in your application until December 23, 2015**. It is your obligation to inform the IRB of any changes in your research protocol that would substantially alter the methods and procedures reviewed and approved by the IRB in this application. Your application has been assigned a project number (#140504), which you should refer to in future correspondence involving the same research procedure.

We also wish to inform researchers that the IRB requires follow-up reports for all research protocols as mandated by Title 45 Code of Federal Regulations, Part 46 (45 CFR 46) for using human subjects in research. We will send a reminder to complete either the Final Report Form or the Extension Request Form to apply for a study continuation. Both forms are available on the IRB homepage. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let us know if the IRB can be of any future assistance.

Regards,

S. Thomson

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