The Effects of Colored Paper on Musical Notation Reading on Music Students with Dyslexia

By

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A Thesis
In
Music Education

Submitted to the Graduate Faculty
of Texas Tech University in
Partial Fulfillment of
The Requirement for
The Degree of

Master of Music Education

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December, 2010

ACKNOWLEDGEMENTS

I would like to say thank you to all the people who have helped me get to this time and place in my life. If it was not for the love, support, and inspiration from the Texas Tech University faculty, friends, and family I would be nowhere. I would like to specifically thank the following individuals for the several years of commitment and inspiration.

Dr. Killian for her patience and understanding for this project.

Dr. Wood for his advice.

Dr. C. Smith for his thoughtful insight.

Dr. Barber without whom, I would have never started this journey.

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ABSTRACT

Previous research established that the use of colored overlays used for children with reading disabilities resulted in great improvement in language arts reading clarity and fluency. This study examined the effects of colored paper on music reading clarity for three dyslexic college students (N=3, 1 female, 2 males) and to evaluate their self-perceptions of reading clarity when reading notation from colored paper versus white paper. Participants were tested over ten days with musical examples printed on a color paper aid of choice and white paper alternating every two days.

Results were determined by evaluating accuracy individually for each participant, and as an overall comprehensive mean in the areas of rhythm, pitch, and combined pitch and rhythm. Results indicated that when the musical examples were printed on the colored paper of choice, the participants read more accurately (85%). The participants' pitch accuracy ranged from 80%-91% when reading on the colored paper, whereas approximately 56%-57% correct when reading on white ($p<.000001$). Results from the analyses showed that all three participants read rhythms significantly more accurately when the musical examples were printed on the colored paper of choice ($p<.000001$). The participants' combined pitch and rhythm accuracy ranged from 80%-88% when reading on the colored paper of choice ($p<.000001$) as compared to approximately 56% correct when reading on white.

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CHAPTER I

VIGNETTE

The background of dyslexia is rarely discussed as a topic of concern in relation to music. However, it became an area of study for me because it was through music that I was introduced to the word dyslexia. I had gone my entire elementary and secondary education never knowing that I had dyslexia. I just knew that reading always took me longer than my peers. Eventually I was placed in reading recovery programs, because I did not read fast enough according the school district I attended. Although my comprehension level was always higher than the school grade I was in at the time, I also suffered with numbers switching around on papers and blackboards, and on occasion I would play music backwards or mix up the pitches or rhythms.

When I came to Texas Tech University my private lesson teacher started noticing all the minor mistakes I was making when I was reading new music. It was this educator who discussed the possibility that I suffered from dyslexia. A few months later with her encouragement I got tested. It came back positive for the learning disorder dyslexia. From this point I began my discovery of dyslexia and what aids are available to students to help with reading accuracy, speed, and comprehension.

CHAPTER II

JUSTIFICATION

Music students with dyslexia have a greater challenge reading music notation clearly and fluently, and have eye fatigue, for which the use of colored overlays might possibly be helpful (Northway, Manahilov, & Simpson 2008). A pilot by Solis (2010) explored the use of printed music on blue paper for a dyslexic musician, resulting in a six percent overall improvement for musical notation reading accuracy. Previous research by Noble, Orton, Irlen and Robinson (1990) established that the use of colored overlays for children with reading disabilities resulted in great improvement in language arts reading clarity and fluency. Wilkins, Sihra and Myers (2005) also studied reading clarity and reading speed among public school children with dyslexia with the use of tinted overlays. Their study examined the precision of tints and number of tints required to improve reading for public school children. At least twenty-five percent of the participants read more quickly with the tinted overlays when the participant used the appropriate color. Note that all prior studies involved the use of colored overlays and or tinted prescribed lenses while reading a printed text; no studies were found which examined the use of colored paper when reading musical notation. Therefore, this study is designed to examine the effectiveness of colored paper as an aid for music reading clarity for dyslexic music students.

CHAPTER III

REVIEW OF LITERATURE

Definition of Dyslexia

According the Mayo Clinic (2009) dyslexia, by definition, is an impairment in the brain's ability to translate written images received through the eyes into meaningful language. Dyslexia is a specific reading disability, a neurobiological disorder that is strongly correlated with normal or superior intelligence. According to Vance (2004) twenty percent of the general population has some form of dyslexia, meaning there are at least a hundred thousand dyslexic students in the United States and billions more throughout the world.

Dyslexia is based upon a person's lack of ability to process words or sounds; precisely stated dyslexia is a phonological developmental tribulation (Breier 2001). This involves problems with phonological structure and sound structure of oral words. Such difficulties include: blending letters into phonemes (e.g., one into o/n/e), recognizing syllables (e.g., breakfast into *break* and *fast*), and differentiating similar phonemes (e.g., p and b). Developing inadequately phonologically correlates with insufficient decoding skills, reading fluency, and spelling intricacy. Phonological deficit extends beyond language development; this problem can also affect children in math and music areas of study (Breier 2001).

Dyslexia and Colored Overlays

In 1983 Sandra Irlen presented the idea of using tinted prescribed filters as lenses to help reading and related learning performances. Irlen claimed that the filters would remove a range of perceptual disorders and specific light frequencies that affect reading

skills and learning performance of children and adults. Perceptual disorders included an impaired ability to perceive objects; music notes and symbols will appear cluttered. The specific light frequencies refer to light waves that are either absorbed or reflected from the material the participants were reading. This condition was titled "scotopic sensitivity" by Irlen, and today it is known as Meares-Irlen syndrome (Kriss & Evans 2005). Meares-Irlen syndrome is a visual discomfort disorder that can include blurring of words, merging or movement of print, eye strain and fatigue, shadowing of letters, restricted focusing and/or problems focusing for extended periods of time (Irlen 1991; Meares 1980). Music students with dyslexia have a greater challenge of reading music notation clearly and fluently than their non-dyslexic peers, and experience eye fatigue, which the use of colored overlays might possibly help (Northway, Manahilov, & Simpson 2008). Irlen claims that people with learning disabilities have a significant scotopic sensitivity. Kriss and Evens (2005) point out that there is no secure evidence stating that dyslexics have Meares-Irlen syndrome, but it is more likely for a person with dyslexia to have the syndrome and/or have the same symptoms. Kriss and Evans (2005) investigated the relationship between dyslexia and Meares-Irlen syndrome in a 2x2 study with sixty-four participants. The participants were matched for age and gender, with equal number of participants in each group, one group being a control group. The participants chose color overlays from thirty different colors, as well as double overlays. The participants were tested with the overlays with the Wilkins Rate of Reading test. There was no statistically significant difference between the two groups (Fisher's exact test, 2 tailed, $p=.20$). The researchers discovered a prevalence of Meares-Irlen syndrome in both the general population and more commonly in the dyslexic population. This study

concluded that the use of a colored overlay is more beneficial to dyslexic children than non-dyslexic children.

Focus of research subsequently shifted away from the idea that dyslexia correlated with Meares-Irlen syndrome. Evans, Cook, Richards, and Drasdo (1994) suggested that the visual difficulties dyslexics encounter, visual anomalies and asthenopia, were the effect of pattern glare from text. Participants in their study ranged from 7 years, 6 months to 12 years, 3 months. There were two groups matched for age and IQ, with one group serving as a control. The participants were asked a series of questions related to visual anomalies that occurred when reading. The researchers investigated this hypothesis in hopes of eliminating the placebo effect that had been encountered in other studies using colored overlays to improve reading accurateness and speed (Evans, Cook, Richards, & Drasdo 1994). The dyslexic group resulted in no significant relationship ($p > .10$) between, amplitude, stability, and the measures of pattern glare. However, the results confirmed considerable evidence suggesting that transient visual systems correlate with dyslexia.

One area of research investigated the use of colored filters to reduce visual noise in visually symptomatic dyslexics (Northway, Nadia, Manahilov, Vletichko, Simpson & William 2008). Northway et al. tested the hypothesis that noise exclusion deficit is an underlying characteristic of dyslexia and that the use of colored filters may affect the visual performance of visual noise symptoms, but not a complete absence of noise. Visual noise is considered in the study as visual distortions and discomfort experienced with reading abilities such as perceptual distortions of shapes, motions, colors, and asthenopia (sore, tired eyes, headaches, and photophobia). The researchers measured contrast of “discriminating letter like symbols in presence and absence of luminance

noise using a two interval forced choice procedure" (Northway, Nadia, Manahilov, Vletichko, Simpson & William 2008, p 3). The participants were tested with the Rate of Reading test, short non-contextual passages of 150 simple words arranged in 10 lines with 15 words on each line. The reading test was completed in 60 seconds; first with colored filters, twice without a colored filter, and lastly with a colored filter in an ABBA format. The dyslexic subjects showed significant increase in reading speed using colored overlays, although they were still significantly slower readers than the non-dyslexic subjects. The researchers conducted a repeated measure ANOVA (dyslexics/non dyslexics x2 [noise/no noise] x3 [no filters/ colored filters/neutral density filters]) with results showing a significant main effect of noise level. A Tukey post hoc comparison showed that dyslexics had a significantly higher contrast discriminating threshold ($P<.005$) without filters then the non dyslexics. In the presence of noise, colored filters reduced significantly the contrast threshold for dyslexics from 5.1% compared to 8.0%, $p=0.001$ when colored filters were used, and more when neutral density filters were used (8.2%, $p<0.001$).

Leat and Nandakumar (2008) suggested that dyslexia is not just a linguistic disability, but also possibly a visual disorder. Leat and Nandakumar found similarities between light and reading dysfunctions of magnocellular deficit, Meares-Irlen syndrome, and dyslexia. These similarities give further support for the idea of using colored overlays or colored lenses to help improve reading function for dyslexics. According to Leat and Nandakumar, there is not enough information to completely correlate both disorders with dyslexia; however there is some evidence that colored lenses may improve reading abilities in dyslexics.

Singleton and Trotter (2005) examined eye stress level in both dyslexics and non-dyslexics, and the effect of colored aids. Singleton and Trotter tested twenty participants, ten diagnosed dyslexic and ten selected from a sample of students whose Visual Processing Problems Inventory scores were already known from a previous research study. The groups consisted of five low scores on the VPPI ('low visual stress') and five high scores on the VPPI ('high visual stress'). All participants were tested with the Wilkins Rate of Reading Test in the Intuitive Colorimeter under two conditions: with their color of choice and without (white light); the test was given in an ABBA design. All groups read faster with the use of the preferred color. The participants with dyslexia and high visual stress increased in reading speed by a mean of 16% when the preferred color was used.

The idea of literacy problems having a direct correlation to visual processing difficulties has become an accepted research area during the last decade (Skottun 2000; Booth, Perfetti, MacWhinney, & Hunt 2000; Stein 2001; Trepocki, Kruk, & Willows 2002). O'Connor, Sofo, Kendal and Olsen (1990) investigated the effects of colored filters on ninety-two children with significant reading disabilities classified as scotopic or nonscotopic. The researchers placed the participants into an expanded Solomon Four group design, with five treatment groups and one control group. The post hoc procedure using the Steel test indicated statically significant changes at a .001 level for reading accuracy, rate, and reading comprehension on the Neale Analysis of Reading Ability and Formal Reading Inventory reading comprehension.

Robinson and Conway (1990) examined the use of colored lenses on forty-four participants between the ages of 9 years 1 month and 15 years 11 months with reading disabilities. The participants were assessed on their own ability for reading improvement

with the Student's Perception Ability Scale at the sixth and twelfth month during this study. The participants showed improvement in reading comprehension and reading accuracy.

Wilkins, Sihra, and Myers (2005) also studied reading clarity and reading speed with public school children with dyslexia with the use of tinted overlays. Their study examined the precision of tints and number of tints required to improve reading for public school children. At least twenty-five percent of the participants read more quickly with the tinted overlays, when the participant used the appropriate color.

Dyslexia and Music Reading

Solis (2010) explored the effect of printing musical examples on blue paper for a dyslexic college student in a pilot study for the current research. The study resulted in a six percent improvement in overall reading clarity. However, when the data were examined more closely, the study distinguished that the blue paper only improved chord accuracy significantly ($p<.000001$), but showed no significant improvement for rhythm accuracy ($p<.39$). The participant strongly indicated that he believed his sightreading improved when notation was written on blue paper.

Music students with dyslexia experience greater difficulty reading music notation clearly and fluently than their non-dyslexic peers, and experience eye fatigue, which the use of colored overlays might possibly help (Northway, Manahilov, & Simpson 2008). The Solis pilot study (2010) gave insight in an area of research that had not been explored. The participant in this study indicated the he felt that he improved in the study, and decided to continue using blue paper for both musical notation reading and language art reading. The results from this study pilot indicated that there was a parallel relationship between language arts reading and musical notation reading. Since the Solis

pilot study had such a positive impact on the participant, it called for further research on a larger sampling of population. Therefore, this study is designed to examine the effectiveness of colored paper as an aid for music reading clarity for dyslexic music students.

CHAPTER IV

METHODOLOGY AND MATERIALS

This study was designed to examine the effects of colored paper on reading clarity for dyslexic music students and to evaluate their self-perceptions of reading clarity when reading notation from colored paper versus white paper. The study was designed as an extended ABA case study (Hersen & Gross 2008).

Procedures and Materials

The study consisted of treatments (colored paper versus white paper) in two-day sessions, over ten days, resulting in five treatments of twenty minutes each. See Table 1.

Table 1

Treatment Schedule

Treatment 1		Treatment 2		Treatment 3		Treatment 4		Treatment 5	
Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	Session 8	Session 9	Session 10
white		colored		white		colored		White	

The treatment schedule followed an ABABA case study design, allowing for "multiple withdrawals and administrations of the independent variable" (Hersen & Gross 2008, p.337). Treatment 1 allowed for a baseline to be established, using black print on white paper, as a pre-intervention to the dependent variable to be observed. Treatment 2 introduced the independent variable, the experimental effect of black print on colored paper.

Each participant was asked to sing or play on their primary instrument the same three musical examples from Ottman's *Music for Sight Singing* (1967) printed on white

paper for sessions one and two to established baseline. Sessions three and four introduced the musical examples printed on colored paper. Each participant chose their preference for a colored paper aid from among: blue, pale yellow, mint green, and violet which are the most commonly found effective colored aids for print reading (Evans, Cook, Richards & Drasdo 1994). As was tested in the pilot study (Solis 2010), the musical examples for session three consisted of one repeated example from session one, and two new examples. The repeated musical example selections were based on the musical excerpts that were played least accurately in the previous treatment. This pattern of a repeated example every third session continued through the study; the repeated example was balanced with the two new examples.

The use of a repeated example is not part of an ABA case design; it is a variation I placed in my study to observe how the participants' playing accuracy would vary based on the repeated measure's printed text on white paper versus colored paper. Logic would state that the participant would play a repeated musical excerpt more accurately the second time it was examined, regardless of the color of paper it was printed on. However, if the paper color had a significant role in playing accuracy, then it was possible that the participant might play the musical excerpt more accurately if was first examined on colored.

The sessions with the participants consisted of twenty minutes divided into two timed sections. The first section was for the purpose of practicing the musical examples. The last section was for the purpose of playing through the musical examples. An audio recording was made of each session on an Edirol R-09HF portable recorder, as well as a video recording on a Lumix DMC-ZS5S digital video camera.

A survey was given to each participant at the end of each session in order to generate further insight into the participant's personal experience during this study, using the same survey as used in the pilot study. The survey was formatted using a Likert scale of 1 (extremely difficult) to 7 (extremely effortless). The survey asked questions about four areas of the treatments: 1) the participants' personal feelings toward practicing the musical examples, 2) the participants' personal feelings toward reading through the musical examples, 3) the participants' self perception of visual clarity of reading the musical examples, and 4) overall notation clarity. Survey appears in Table 2.

Table 2

Attitude Survey of the Individual's Perception

Please circle a number indicating how you felt for each of the following question on a scale of 1 (extremely difficult) to 7 (extremely effortless) to the following questions:
I felt practicing example Number 4 was:
1 2 3 4 5 6 7
I felt practicing example Number 12 was:
1 2 3 4 5 6 7
I felt practicing example Number 15 was:
1 2 3 4 5 6 7
I felt that playing through example Number 4 was:
1 2 3 4 5 6 7
I felt that playing through example Number 12 was:
1 2 3 4 5 6 7
I felt that playing through example Number 15 was:
1 2 3 4 5 6 7
Please circle a number indicating how you felt for each of the following question on a scale of 1 (reading clarity is difficult) to 7 (reading clarity is effortless) to the following questions:
The level of reading clarity I experienced while reading the examples on white was:
1 2 3 4 5 6 7
The level of reading clarity I experienced while reading the notes on white was:
1 2 3 4 5 6 7

The surveys were printed on either colored or white paper in accordance to what color was being implemented each treatment. The participants were video recorded while filling out the surveys. In addition to the surveys, the participants also shared opinions about their session in unstructured interviews at the end of each session. These interviews were also recorded.

Participants

The participants for this study were recruited by emails sent to faculty members from a large, southwestern, accredited university, with a recognized strong music

program, asking them to invite dyslexic students they knew to participate in a dyslexia study. In addition, a mass email was sent out to all undergraduate students at the same university who were enrolled as music majors. All participation was on a volunteer basis. All participants had to be currently or have been previously clinically diagnosed with dyslexia. This information was established in confidence with each individual prior to the study.

I was able to recruit three participants (N=3, 1 female and 2 male): Rose a vocalist, Chris a harpist, and Joe a trumpet player. The participants' actual names and name of the university are not being used for their privacy in this study. All three participants were music majors, at different degree levels, and had been diagnosed with dyslexia.

Rose: As a Ph D student in music, she noticed she had difficulty with letters and symbols, but like so many other students, never knew she suffered from dyslexia. Rose was first diagnosed during her undergraduate education. Rose stated that she had suffered from eye strain and fatigue, but never thought about it. She never knew or imagined that her dyslexia had an effect on her music reading ability. In this study Rose chose the colored paper yellow to be her aid. Rose chose this color claiming "it wasn't as straining to look at when reading" (M.Solis, personal communication, April 14, 2010).

Chris: He was currently working on his bachelor of music and has suffered from a severe diagnosis of dyslexia all his life. Chris was diagnosed as a child, and has experienced both word and music reading challenges since then. He did not receive assistance in his secondary education; however, he did receive assistance when attending college. Chris chose the blue colored paper as his aid. Chris stated that the print on blue "seemed bolder,

clear, and it made it easier for him to process the information" (M. Solis, personal communication, April 16, 2010).

Joe: He was an undergraduate in music education major and was diagnosed with dyslexia during his elementary education. Joe received several years of assistance with his dyslexia, and eventually tested out of special education at the end of middle school. Joe decided to do this study because he noticed that he still needed help today with his learning disability, and hoped that this study will provide additional coping strategies for students with dyslexia. Joe decided on the rose colored paper as his aid in this study. Joe chose the rose paper claiming that "it looked better, like red and black just go better together" (M. Solis, personal communication, April 16, 2010).

All portions of the study were conducted individually by appointment. Since the study included participants with learning disabilities, consent forms were used for each participant; using the procedures established by the Texas Tech Institutional Review Board (IRB). IRB approval documents and participant consent form appear in Appendix A and Appendix B. Recruitment letters can be found in Appendix C and Appendix D.

CHAPTER V

RESULTS

This study actually explored three separate inquires, the effect of colored paper: rose, blue, and yellow improve music reading clarity because each individual chose a different colored paper as their experimental aid. Since this study is actually three combined individual experiments, the data were analyzed in two parts: 1) as a comprehensive total and 2) individually for each participant.

The audio recordings of each session were analyzed for correct and incorrect rhythms and pitches. The data were first analyzed combined and overall. Secondly, the data were analyzed for each individual participant. The subsequent total number of correct and incorrect rhythms and pitches were analyzed with the Chi Square static to determine if reading musical notation printed on colored paper improves clarity of reading, and accuracy of rhythm and pitch.

Data consisted of frequency of correct and incorrect pitches and rhythms, individually and combined, for each musical example. In sum, and counting each session with each participant, there were a total of twenty-seven musical examples; including three of the examples, which were repeated during the testing period for comparison purposes. The audio recordings were analyzed independently by two adjudicators, the researcher and a musician colleague who has five years of symphony experience. The adjudicators listened to the musical examples, scoring each pitch and rhythm as correct or incorrect. Judges' scores were combined and averaged for a resulting single score for each example. The adjudicators listened to the recording of the musical examples

independently with Bose noise cancelling head phones, and were given copies of the music on which to notate errors.

Comprehensive Results

The results were analyzed by means of a Chi Square using the mean total correct /incorrect scores for both rhythm and pitch for white paper versus combined colored papers. Results indicated that when the musical examples were printed on the colored paper of choice, the participants read more accurately (85%). See Figure 4.1.

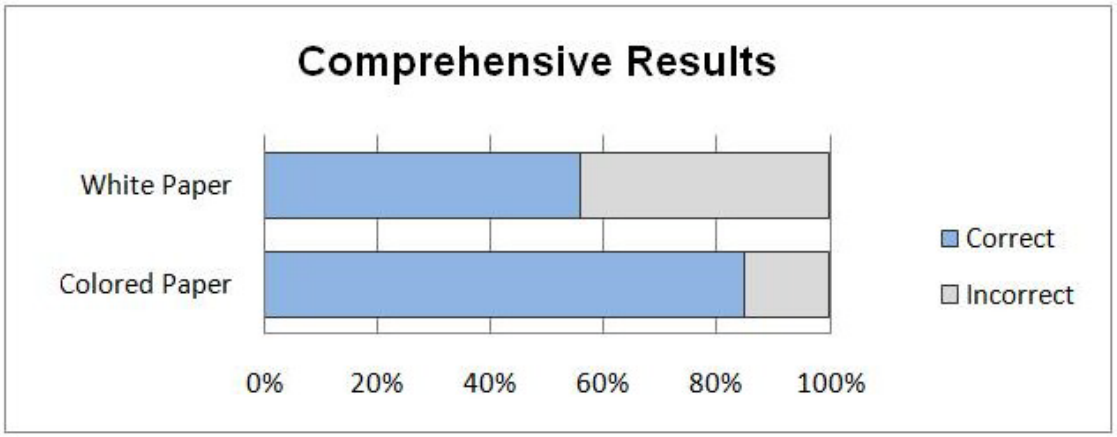

Figure 4.1: This figure displays the combined mean scores for all participants pitch and rhythm accuracy when reading the musical examples on the paper color aid of choice versus on the white paper.

The chi square analysis indicated that all participants scored significantly more accurately with the use of the colored aid of choice ($p<.00001$). See Figure 4.2

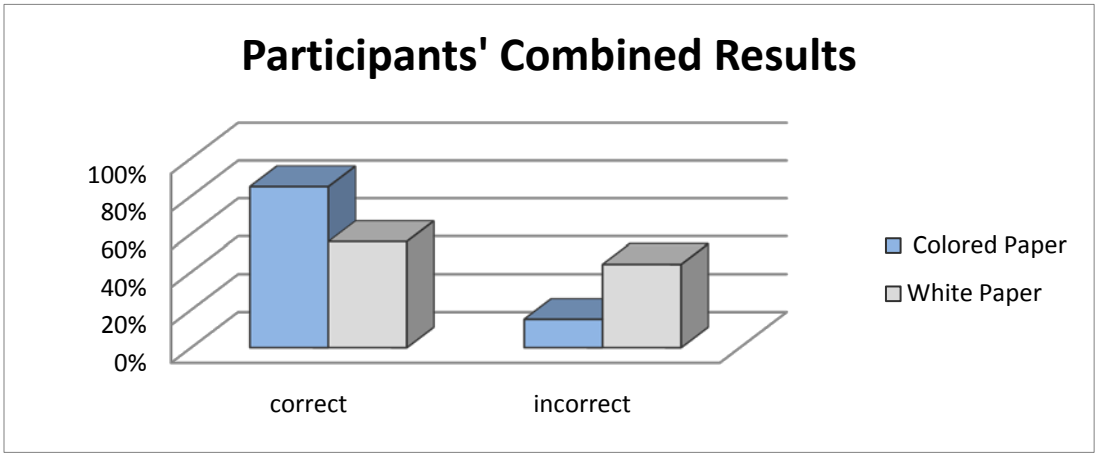

Figure 4.2: The participants combined percentages comparing correct and incorrect combined pitch and rhythmic values for colored versus white paper. The figure displays correct and incorrect percentages side by side. Overall, the participants read more accurately (85%) when reading on the colored paper of choice than on white paper (56%).

Pitch Results

McNemar test for significance (Siegel & Castellan, 1988) was used to compare accuracy scores when using the colored paper versus white paper due to the two-sample, dependent nature of these data. For reporting purposes frequency mean scores were converted to percentages to account for differences in length among musical examples. Results indicated that all participants played significantly more incorrect pitches on white paper versus the colored paper ($p<.000001$). The participants' pitch accuracy ranged from 80%-91% when reading on the colored paper, whereas approximately 56%-57% correct when reading on white. See Figures1.1-1.3.

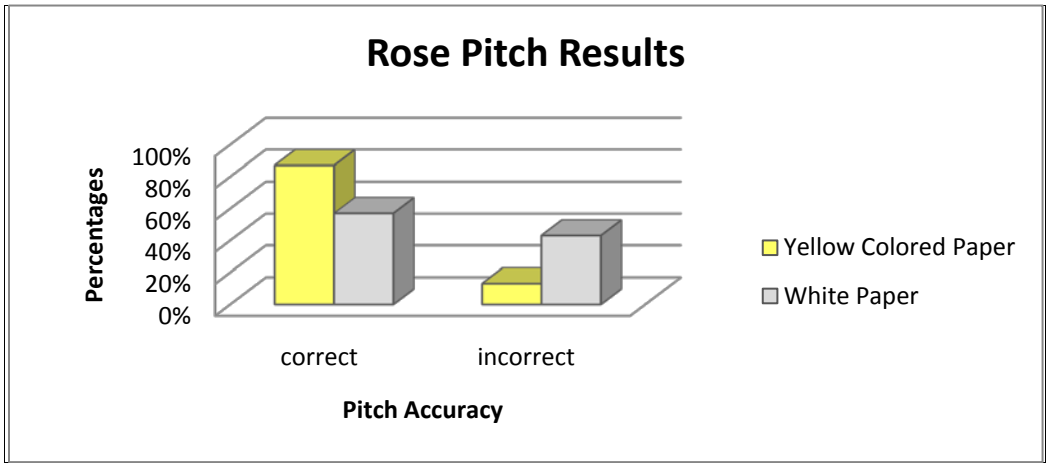

Figure 1.1: Rose's percentages comparing correct and incorrect pitch values for yellow and white paper. The figure displays correct and incorrect percentages side by side. Rose read 87% correct pitches on yellow paper versus 57% correct on white paper. She read 13% incorrect on yellow paper versus 47% incorrect on white paper.

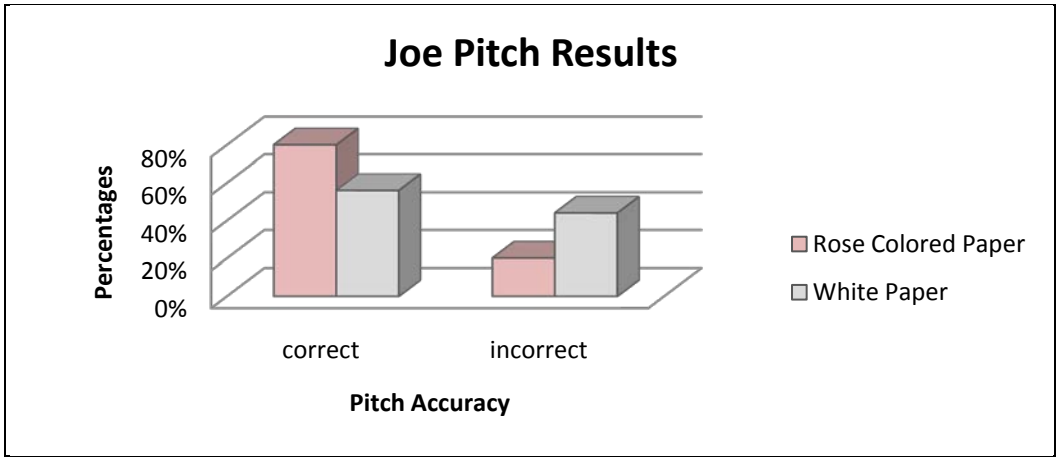

Figure 1.2: Joe's percentages comparing correct and incorrect pitch values for rose and white paper. The figure displays correct and incorrect percentages side by side. Joe read 80% correct pitches on rose paper versus 56% on white paper. Additionally, he read 20% incorrect on rose paper versus 44% on white paper.

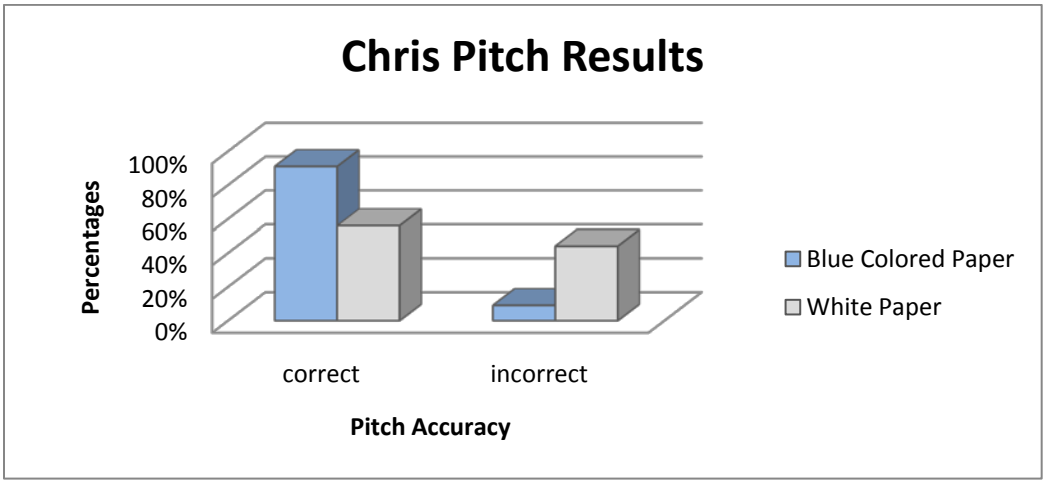

Figure 1. 3: Chris' percentages comparing correct and incorrect pitch values for blue and white paper. The figure displays correct and incorrect percentages side by side. Chris read 91% correct pitches on blue paper versus 56% correct on white paper. He read 9% incorrect on blue paper versus 44% incorrect on white paper.

Rhythm Results

Analysis of the results from the McNemar analyses showed that all three participants read rhythms significantly more accurately when the musical examples were printed on the colored paper of choice ($p<.000001$). See figures 2.1-2.4

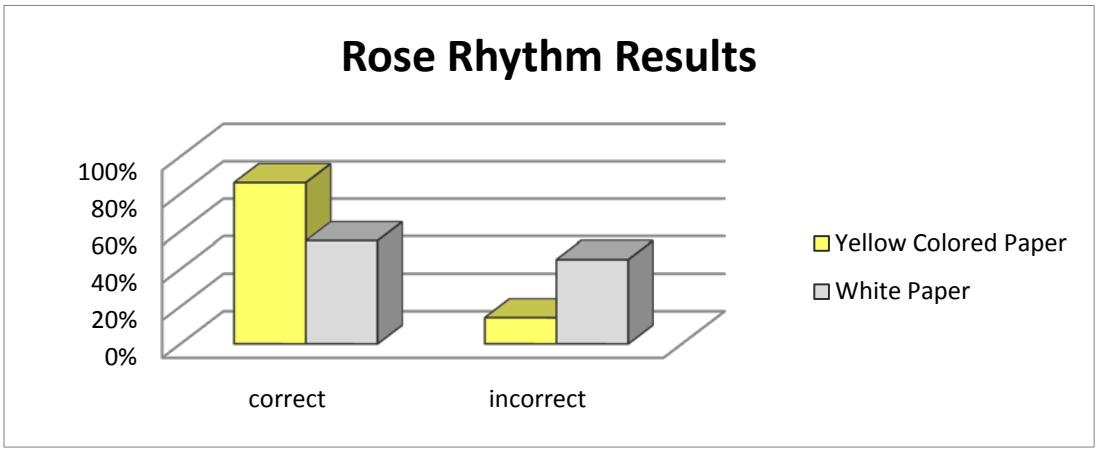

Figure 2.1: Rose's percentages comparing correct and incorrect rhythmic values for yellow and white paper. The figure displays correct and incorrect percentages side by side. Rose read 86% correct rhythms on yellow paper versus 55% correct on white paper; whereas, she read 14% incorrect on yellow paper versus 45% incorrect on white paper.

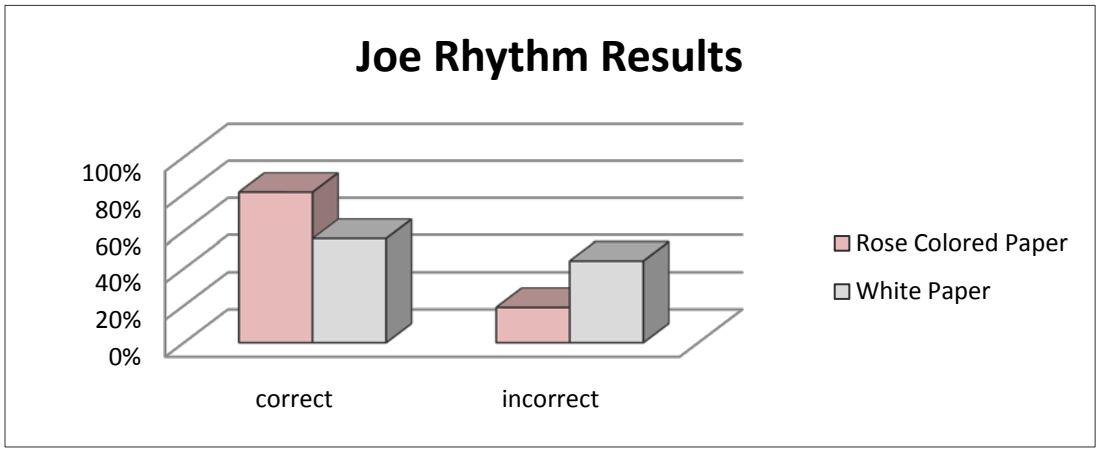

Figure 2.2: Joe's percentages comparing correct and incorrect rhythm values for rose and white paper. The figure displays correct and incorrect percentages side by side. Joe read 19% correct rhythms on rose paper versus 56% correct on white paper; whereas he read 14% incorrect on rose paper versus 44% incorrect on white paper.

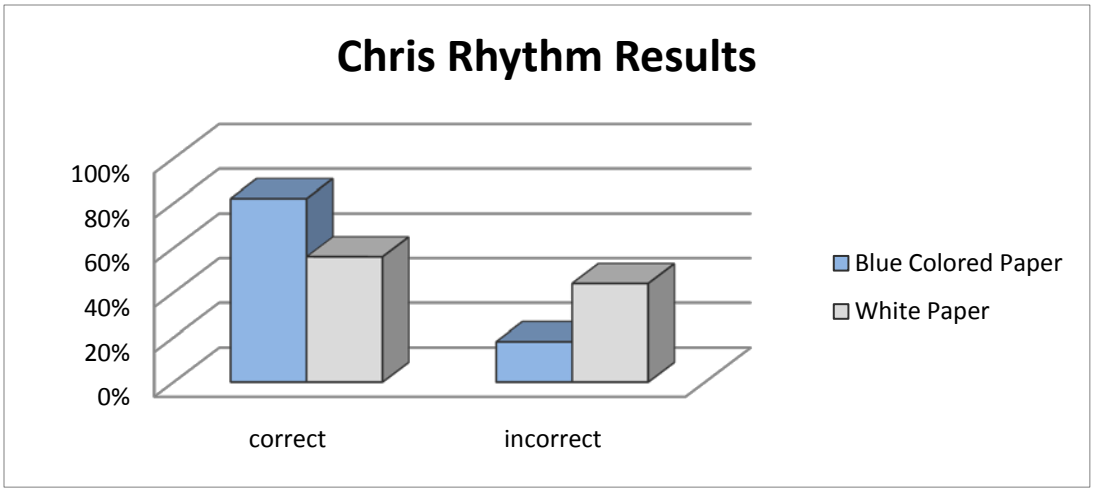

Figure 2.3: Chris' percentages comparing correct and incorrect rhythm values for blue and white paper. The figure displays correct and incorrect percentages side by side. Chris read 82% correct rhythms on yellow paper versus 56% correct on white paper; whereas, he read 18% incorrect on yellow paper versus 45% incorrect on white paper.

Combined Pitch and Rhythm Results

With both pitch and rhythm combined there was a significant improvement when the participants read the musical examples on the colored paper of choice. The participants' combined pitch and rhythm accuracy ranged from 80%-88% when reading

on the colored paper (p<.000001) as compared to approximately 56% correct when reading on white. See Figures 3.1-3.3.

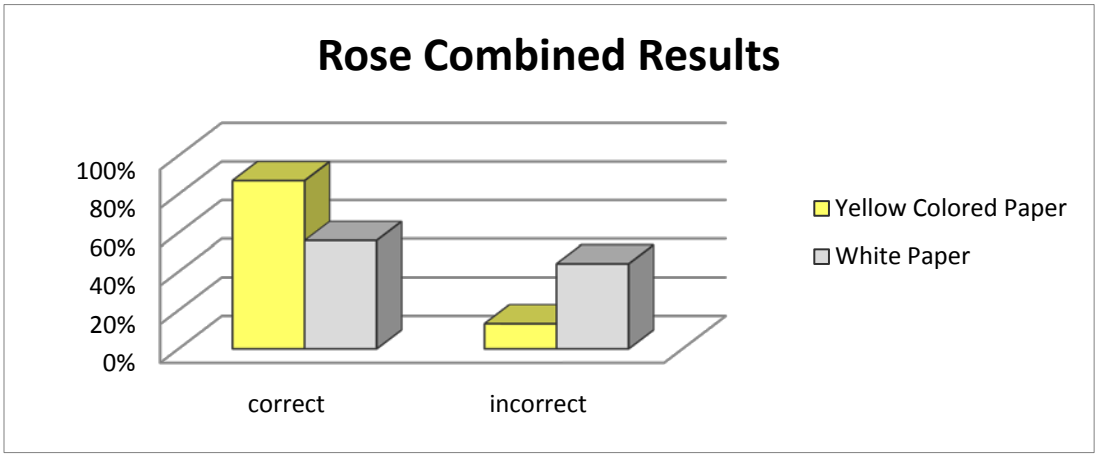

Figure 3.1: Rose's percentages comparing correct and incorrect combined pitch and rhythmic values for yellow and white paper. The figure displays correct and incorrect percentages side by side. Overall, Rose read more accurately (87%) when reading on yellow paper than on white paper (56%).

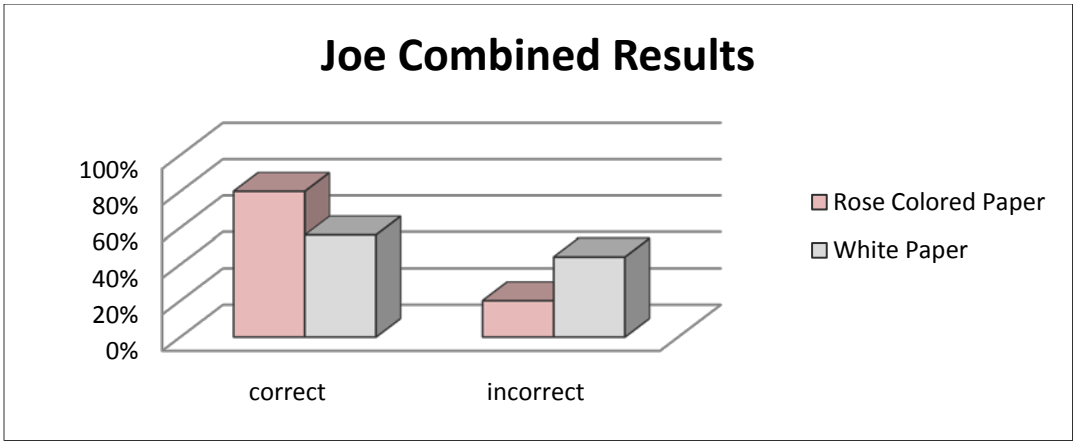

Figure 3.2: Joe's percentages comparing correct and incorrect combined pitch and rhythm values for rose and white paper. The figure displays correct and incorrect percentages side by side. Overall, Joe read more accurately (80%) when reading on rose paper than on white paper (56%).

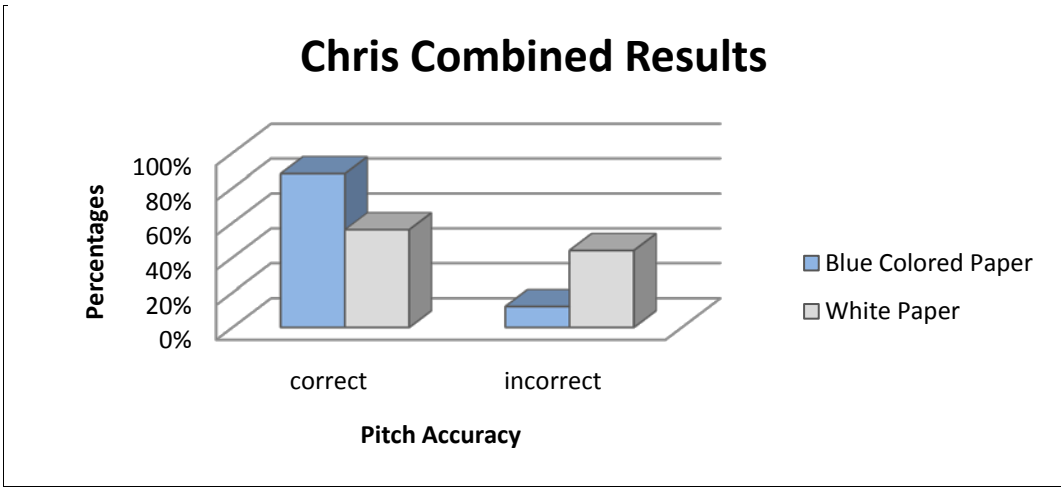

Figure 3.3: Chris' percentages comparing correct and incorrect combined pitch and rhythm values for blue and white paper. Overall, Chris read more accurately (88%) when reading on blue paper than on white paper (56%).

Participants' Self Perception Surveys

The responses to the written surveys following each practice session were averaged for each individual participant in three categories 1) practice mean, 2) play through mean, and 3) reading clarity mean. The surveys examined how each individual perceived how they felt at each session. The participants scored how they felt about each session using a formatted Likert scale of 1 (extremely difficult) to 7 (extremely effortless). The surveys asked the same questions every session over four areas of the treatments: 1) the participants' personal feelings toward practicing the musical examples, 2) the participants' personal feelings toward reading through the musical examples, 3) the participants' self perception of visual clarity of reading the musical examples, and 4) overall notation clarity. See Figures 5.1-5.3

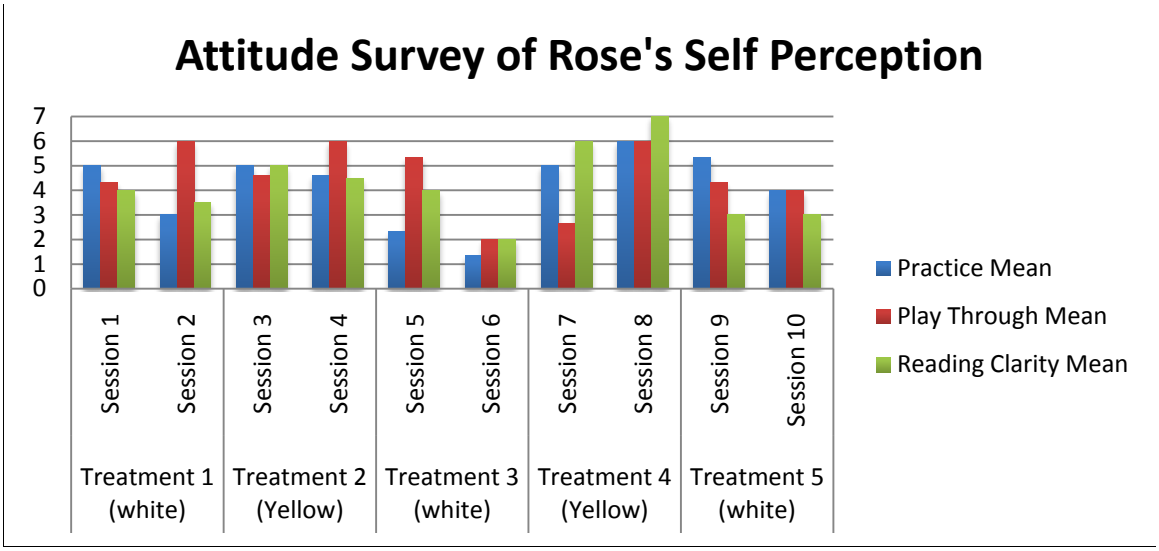

Figure 5.1: This figure represents the mean of the participants self survey for Rose's perception of reading clarity on yellow and white paper.

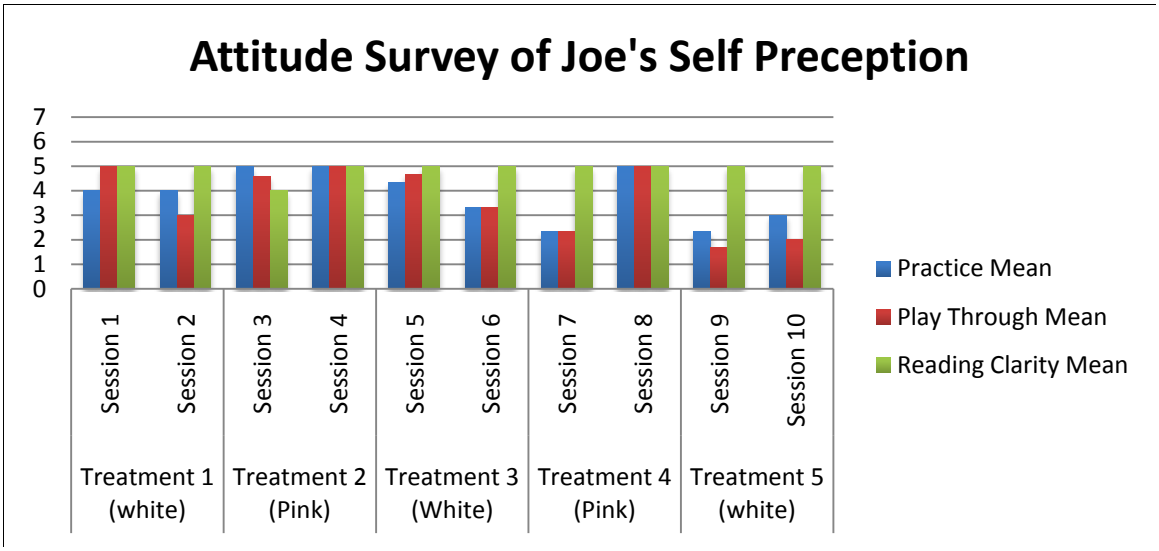

Figure 5.2: This figure represents the mean of the participants self survey for Joe's perception of reading clarity on rose and white paper.

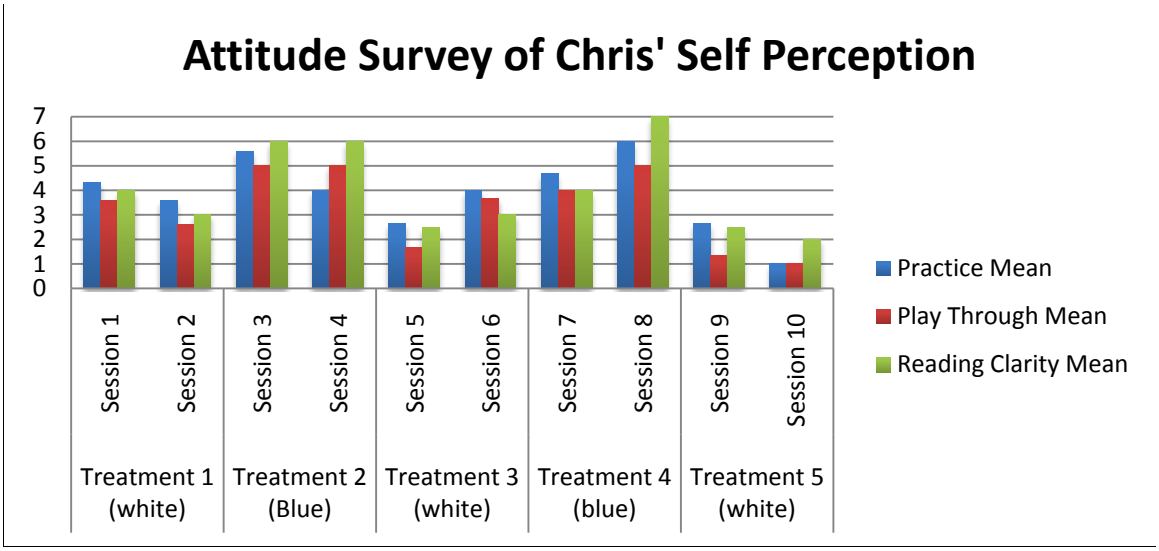

Figure 5.3: This figure represents the mean of the participants self survey for Chris' perception of reading clarity on blue and white paper.

CHAPTER VI

DISCUSSION

The results of this study concur with results of the pilot study (Solis 2010) regarding the positive value of printed musical text on colored paper. The pilot study (Solis 2010) concluded that musical text printed on the colored paper blue had a significant impact on music reading clarity ($p>.000001$). This study, however, found improvement in all music reading areas: pitch, rhythm, and overall accuracy, not just pitch and overall accuracy, as occurred with the pilot study cited above. The improvement in music reading accuracy with the colored paper aid corroborates studies on the use of colored aids, colored lenses and colored overlays to improve literature text reading (Noble et al., 2004, Jeanes et al., 1997).

In recent as well as less recent studies, there has been research surrounding the relationship of music and language skills. These studies examined the interrelationship between music learning skills and language learning skills of non-dyslexic participants. According to Barwick, Valentine, West and Wilding (1989), seven- to eleven-year-old children showed parallels between tonal memory, chord study, and reading level. The same similarities were found in studies involving children with dyslexia. Overy (2003) and Wolff (2002) found that children with reading disabilities or dyslexia have tribulations with rhythm perception. In addition, Atterbury (1985) also discovered dyslexic children ages seven through nine had difficulty with pitch perception as well as rhythm perception.

What cannot be explained by a phonological structure deficit is the difficulty with learning to read music notation by dyslexic children (Jaarsma, Ruijssenaars & Van den

Broeck 1998). This suggests that dyslexic children have problems with sound grouping, and "mapping of sounds to visual symbols" (Forgeard, Schlaug, Norton, Rosam, & Iyengar 2008). It was the researcher's speculation that based on the results of each individual participant, colored paper would be an advantage for musicians and music students who have been diagnosed with dyslexia, especially since musicians frequently write on their music. This current study verified this speculation.

The conditions of this study were designed to examine how each participant would practice and perform new pieces of music in a short practice period situation. The participants were placed in a private room, given the musical examples, and a pencil at each session, and were instructed they would have a timed ten minutes to practice the musical examples as they would for a regular practice period (i.e. clap, sing, dance the musical excerpts, write on the musical excerpts etc.,). Next, the participants were given a maximum of ten minutes to play the musical examples all the way through. The audio recordings of the play through of the musical examples were the only recordings that were analyzed; however, each session was both audio and video recorded.

Although it was beyond the scope of this study, it would be interesting to review the video recordings to see what if any physical discomforts were noticeable (i.e. leaning toward the paper, rubbing of the eyes, pointing or physically touching each note etc.,) for further comparison between treatments of white and colored paper. Also, a comparison of pencil marks each participant made on the musical examples on the white and colored paper might give further insight on the effect of the paper they were reading from each day. The repeated examples were not analyzed independently for this study, but it should be noted that each individual participant played more accurately when the examples were

printed on the colored paper of choice, even when the musical examples were read second on the white paper aid.

Attitude Surveys

The participants were given an attitude survey of self perception to complete immediately following each session. The surveys were completed by the participants with me in the room while having a discussion about the session, each discussion began with me asking the participant "So, how was today?" The results varied, but overall the majority indicated that the colored paper did improve visual clarity when reading. See Figures 5.1-5.3.

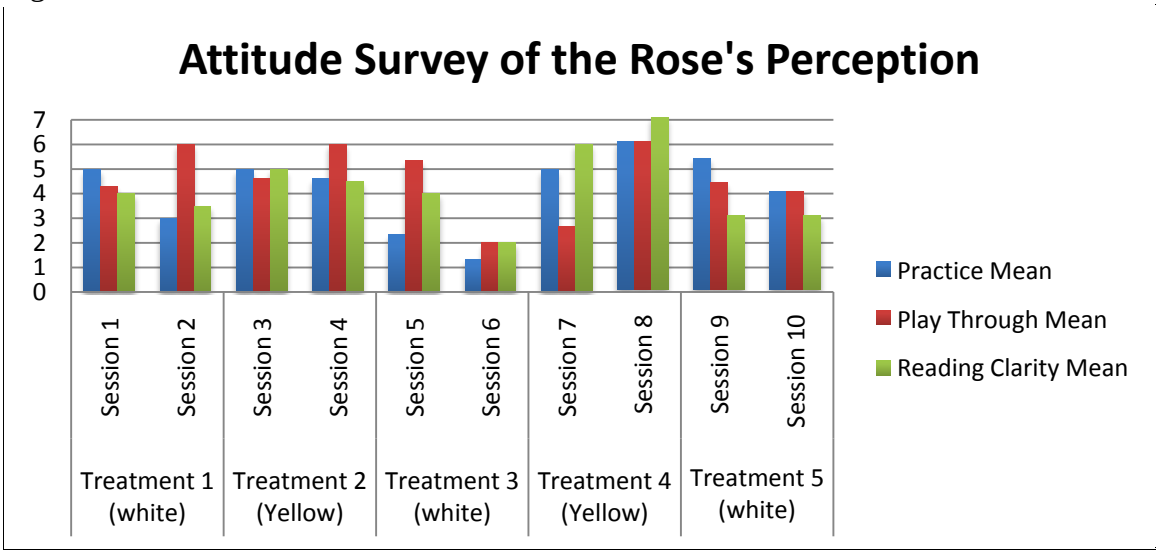

Figure 5.1: This figure represents the mean of the participants self survey for Rose's perception of reading clarity on yellow and white paper.

Rose's answers to the survey for the first two treatments were close, indicating that she noticed little to no difference in visual clarity with colored paper. However, with treatment three reintroducing white paper, the results indicate that Rose did feel a visual discomfort when reading on the white paper after reading on the yellow paper. The end results of Rose's survey indicate that she felt that the yellow paper improved her visual clarity. When Rose began this study she stated that she "did not believe the yellow paper

would have any effect on visual clarity" (M. Solis, personal communication, April 14, 2010). At the end of session three Rose stated that the yellow paper "is a lot easier on the eyes, umm it's not as tiring…there's not as much strain on the eyes. I'm not sure if it's the light bouncing off the white, or the light being absorbed by the yellow. It's just different. It's kinda like wearing sunglasses, if that makes any sense? It cuts out the white light reading it on yellow instead of yellow" (M. Solis, personal communication, April 21, 2010). Rose also mentioned that the yellow paper did help, and that visual difficulty when reading did increase when there was more "stuff on the paper, the more notes the more difficult it is to read" (M. Solis, personal communication, April 22, 2010). At the end of session five I asked Rose "In comparison, now that we're back on white versus when we were on yellow…what do you think? What is easier for you?" Rose stated "You know what is interesting? When we started off with white that was the only thing I've ever done. I didn't know a difference. Then we went to yellow it seemed a whole lot easier and less stressful to the eyes. Now that we're back to white, I'm noticing how difficult white is" (M. Solis, personal communication, April 23, 2010).

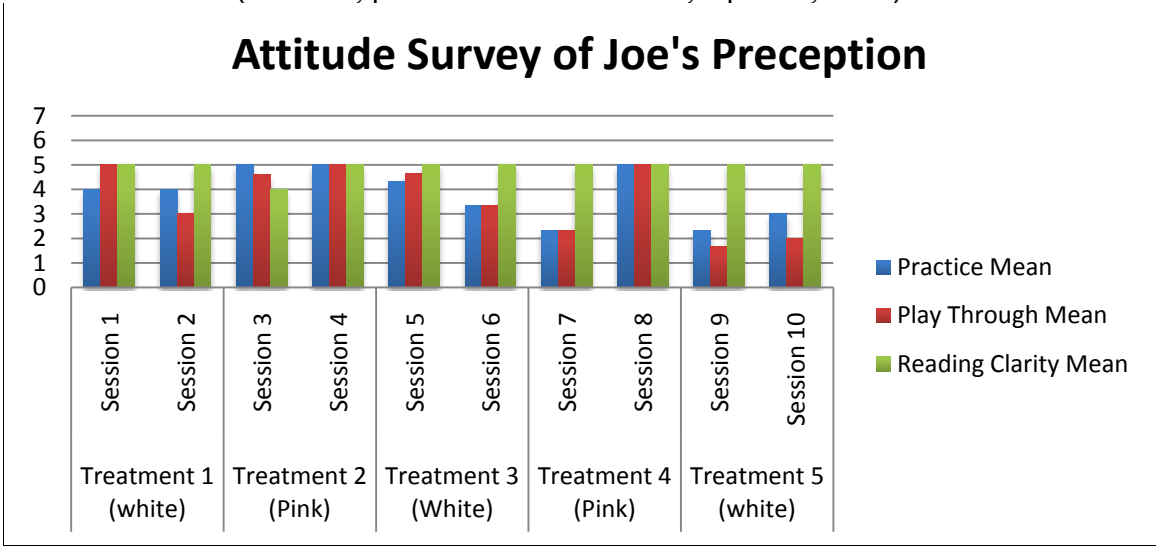

Figure 5.2: This figure represents the mean of the participants self survey for Joe's perception of reading clarity on rose and white paper.

Joe's answers to the survey indicate that visually he did not detect a difference in visual clarity between the rose and white paper. At the end of session five Joe stated " I can't tell a difference between the color. I'm just trying to hear the music. I know some dyslexic people out there that have a problem with color, but that one has never been an issue. Unless otherwise you can tell me if there is an issue" (M. Solis, personal communicaiton, April 24, 2010). At the end of the study I asked Joe whether he noticed a difference in the colored paper and white paper. Again he said no; however, the chi-square results signified that Joe did play significantly more accurately when he read on the rose colored paper. It is the researcher's opinion that the participant Joe was uneven about his diagnosis of dyslexia, and so this effected his opinion about the study. Joe never openly shared what he thought he was constantly questioning the researcher for what he should think and/or feel.

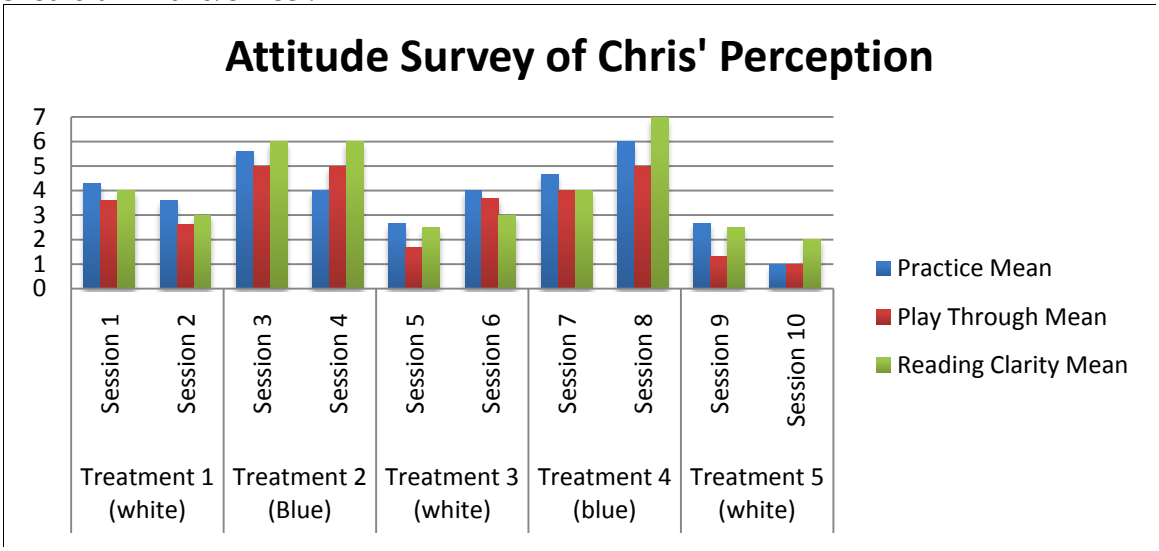

Figure 5.3: This figure represents the mean of the participants self survey on Chris' perception of reading clarity on blue and white paper.

Chris' survey answers unquestionably show that he believes his visual clarity is better when he is reading on blue. At end of the study Chris stated "the blue paper just makes it easier, it makes me think differently. I'm able to see the patterns in the music

faster, I can see what my hands have to do" (M. Solis, personal communication, April 22, 2010). In the last session, when I asked Chris what he thought about when he reading from the white paper, he stated " It was difficult…Visually,…the more things on the page, like…as I was sitting in here circling these two down here…the numbers on this page…were doing stuff…they were just doing stuff" (M. Solis, personnal communication, April 29, 2010). The reseracher believes that Chris' reference that the number two was "doing stuff" coincides with previous research about visual anomalies (Evans, B.et al., 1994). Chris did not specifically state what he meant by "doing stuff"; the researcher believes he was referring to visual blurring or scattering of the text.

It should be noted that dyslexia affects individuals differently and so the use of colored aids may not seem to be efficient for all students. It should be noted, however, that regardless of student opinion, all participants had significantly fewer errors using their preferred colored paper. Rose and Chris expressed the opinion that the "more stuff on the page, the more difficult" the musical examples were to read.

What I think is the most important factor of this study to remember is to listen to your students. Since these perceptions seemed to vary so much from participant to participant, it would lead to the conclusion that good teachers should listen closely to their students and believe what those students they are trying to tell them.

The question remains whether the significant improvement in reading accuracy for all three participants when using the colored paper could be due to a placebo effect. However, it could be argued, if the participants continued to use the color paper for printed music for a prolonged period, it could be perceived that the participants are receiving a benefit beyond that attributed to motivation and expectation from this study. It could also be argued that the colored paper will only improve the participants' musical

reading skills and achievements because of the effect of significant improvement in visual clarity, resulting in less frustration when learning new music.

The study observed three individuals over a short period of time, in one geographical location. Results from this study should be generalized to a larger population with care based on inherent limitations with the design of the study. Results could vary with the use of more participants; more participants may provide a more precise look at the effects of printed text on colored paper for music students and musicians who have dyslexia.

Implications for Future Research

This study sought to investigate the effect of printed musical text on colored paper, when implemented a tool in a regular practice period for participants with dyslexia. Further research should explore the effects of printed musical text on colored paper in a wider range of settings for music students and musicians who have dyslexia, such as in a music classroom or rehearsal period; as well as over an extended period of time. This type of research would increase validity of the results and help determine whether the results would hold true for a variety of populations.

This study could also be used to examine several extensions of this simple ABA design, by changing the basis of the element being studied such as: complex meter and simple meter, line spacing of the musical staff, stem direction, or other notation issues. Another way to replicate this study would be to observe the effect of musical text printed on colored paper when sight reading. Participants would strictly view and record immediately each musical example, interchanging the white paper and colored paper as modeled in the treatment schedule.

Finally, research is essential as a continuum in everyday life, as a learning tool for both the researcher and the participant. There have been extensive studies focusing on dyslexia and the effect of colored aids, colored lenses and overlays, for reading accuracy, but there is little research in the effect of aids upon music reading accuracy. It is the researcher's conclusion, based on the results of this study, that the use of colored paper for music reading accuracy concerning music students and musicians with dyslexia needs to be further researched. It should be stressed that when learning to read music there are several complex steps between cause and effect in the area of musical literacy development. While this study may give a simple answer regarding the improvement of reading accuracy through the use of a colored paper aid, it may not be the only answer. However, the results of this study suggest that the use of the colored paper should be considered as a possible option to help the visual clarity for music students, and musicians with dyslexia.

BIBLIOGRAPHY

Atterbury, B. W. (1985). Musical differences in learning disabled and normal-achieving readers, aged seven, eight and nine. *Psychology of Music,* 13, 114-123.

Barwick, J., Valentine, E., West, R., & Wilding, J. (1989). Relations between reading and musical abilities. *British Journal of Educational Psychology, 59,* 253-257.

Booth, J.R., Perfetti, C.A., MacWhinney, B., & Hunt, S.B. (2000). The association of rapid temporal perception with orthographic and phonological processing in children and adults with reading impairment. *Scientific Studies of Reading,* 4 (2), 101-132.

Evans, B., Cook, A., Richards, I., and Drasdo N. (1994). Effect of pattern glare and coloredoverlays on a simulated-reading task in dyslexics and normal readers. *American Academy of Optometry*. 71 (10), 619-628.

Evans, B. J. W. and Joseph, F. (2002). The effect of coloured filters on the rate of reading in an adult student population. *Ophthalmic and Physiological Optics*, 22 (6), 535-545.

Forgeard, M., Schlaug, G., Norton, A., Rosam, C., & Udita I. (2008). The relation between music and phonological processing in normal-reading children and children with dyslexia. *Music Perception,* 25 (4), 383-390.

Hersen, M., and Barlow, D. H. (1976). *Single case experimental designs: Strategies for studying behavior change.* Pergamon Press.

Hersen, M., and Gross, A.M. (2008). *Handbook of clinical psychology: Children and adolescents.* John Wiley & Son, Inc.

Irlen, H. (1991). *Reading by the colors*. New York: Avery.

Jaarsma, B., Ruijssenaars, A., & Van Den Broeck, W. (1998). Dyslexia and learning musical notation: A pilot study. *Annals of Dyslexia,* 48, 137-154.

Jeanes, R., Busby, A., Martin, J., Lewis, E., Stevenson, N., Pointon, D., and Wilkins A. (1997). Prolonged use of coloured overlays for classroom reading. *British Journal of Psychology,* 88, 531-548.

Kazdin, Alan E. (1982). *Single-case research designs: Methods for clinical and applied settings.*Oxford University Press.

Kriss, I., and Evans, B.J. (2005). The relationship between dyslexia and Meares-Irlen syndrome. *Journal of Research in Reading*. 28 (3), 350-364.

Leat, S.J., and Nandakumar, K. (2008). Dyslexia: A review of two theories. *Clinical and Experimental Optometry*. 91 (4), 333-340.

Mayo Foundation for Medical Education and Research (2009, August 27). *Dyslexia.* Retrieved from http://www.mayoclinic.com/health/dyslexia/DS00224

Noble, J., Orton, M., Irlen, S., and Robinson, G. (1990) A controlled field of the use of coloured overlays on reading achievement. *Journal of Learning Disabilities.* 23 (10) 597-603.

Northway, Nadia. (2003). Predicting the continued use of overlays in school children-a comparison developmental eye movement test and the rate of reading test. *Ophthalmic and Physiological Optics.* 23 (5), 457-464.

Northway, N., Manahilov, V., and Simpson, W. (2008). Colored filters improve exclusion of perceptual noise in visually symptomatic dyslexics. *Nature Precedings* <http://hdl.handle.net/10101/npre.2008.1729.1>

O'Connor, P., Sofo, F., Kendall, L., and Olsen, G. (1990). Reading disabilities and the effects of colored filters. *Journals of Learning Disabilites.* 23 (10).

Overy, K. (2003). Dyslexia and music. From timing deficits to musical intervention. *Annals of the New York Academy of Sciences*, 999 (1), 497-505.

Ottman, R. W. (1967). *Music for sight signing second edition.* Englewood, Cliffs, NJ: Prentice Hall Inc.

Robinson, G. and Conway, R. (1990). The effects of Irlen colored lenses on students'specific reading skills and their perception of ability: A 12 month validity study. *Journal of Learning Disabilities.* 23 (10), 589-596.

Siegel, S. and Castellan, N.J. Jr. (1988). *Nonparametric statistics for the behavioral sciences.* New York: McGraw-Hill Book Company.

Singleton, C., and Trotter, S. (2005). Visual stress in adults with and without dyslexia. *Journal of Research in Reading*, 28 (3), 365-78.

Skottun, B.C. (2000). The magnocellular deficit theory of dyslexia: The evidence from contrast sensitivity. *Vision Research*, 40, 111-127.

Solis, M.A. (2010). The effects of colored paper on musical notation reading on a student with dyslexia: A pilot study. Paper presented at the Research Poster Session of Texas Music Educators Association. San Antonio, TX.

Stein, J.F. (2001). The magnocellular theory of developmental dyslexia. *Dyslexia*, 7, 12-36.

Terepocki, M., Kruk, R.S., & Willows, D.M. (2002). The incidence and nature of letter orientation errors in reading disability. *Journal of Learning Disabilities*, 35 (3), 214-233.

Vance, Kate O'Brien. (2004). Adapting music instruction for students with dyslexia. *Music Educators Journal*. 90 (5), 27-31.

Wilkins, A. (2002) Coloured overlays and their effects on reading speed: A review. *Ophthalmic and Physiological Optics*. 22 (5), 448-454.

Wilkins, AJ., Sihra N., and Myers, A. (2005) Increasing reading speed by using colours: issues concerning reliability and specificity, and their theoretical and practical implications. *Perception.* 34, 109-120.

Wolff, P. (2002). Timing precision and rhythm in developmental dyslexia. *Reading and Writing, 15*, 179-206.

APPENDIX A

HUMAN SUBJECTS APPROVAL

TEXAS TECH UNIVERSITY
Research Services

November 20, 2009

Janice Killian
Music - V&PA
Mail Stop: 2033

Regarding: 502145 Dyslexia and the Effects of Colored Paper for Reading Musical Notation: A Pilot Study

Dr. Janice Killian:

The Texas Tech University Protection of Human Subjects Committee has approved your proposal referenced above. The approval is effective from November 19, 2009 through October 31, 2010. This expiration date must appear on all of your consent documents.

You will be reminded of the pending expiration approximately eight weeks prior to October 31, 2010 and asked to give updated information about the project. If you request an extension, the proposal on file and the information you provide will be routed for continuing review.

Sincerely,

Rosemary Cogan, Ph.D., ABPP
Protection of Human Subjects Committee

203 Holden Hall | Box 41035 | Lubbock, Texas 79409-1035 | T 806.742.3884 | F 806.742.3892

APPENDIX B

PARTICIPATION CONSENT FORMS

Texas Tech University
School of Music
Consent Form Research Project Information

Supervising Professor: Dr. Janice Killian
Janice.Killian@ttu.edu (806) 742-2270 ext 264

Researcher: Madonna Solis
madonna.solis@ttu.edu
(304)203-6717

I. Purpose:

The purpose of this study is to examine the effects of colored paper on music reading clarity for a dyslexia college student.

II. Procedure:

1. The study will consist of treatments: color paper versus white paper in two-day increments, resulting in five treatments of two ten minute sessions over ten days.

2. You, the participant will be given three musical examples during each treatment meeting. I will ask you to read and play the examples.

3. You, the participant will be audio and video recorded during your practice and playing through of all the musical examples.

4. For privacy, resulting audio recordings will be kept in a locked file cabinet in the music education library of Texas Tech University. You and your school will not be referred to by name.

5. The recordings will be analyzed for correct and incorrect rhythms and pitches. Results will determine if reading musical notation on blue paper improves clarity of reading, and accuracy of rhythm and pitch.

III. Respect for the Individual:

Participation in this project is **voluntary** and no one will be included without his/her informed consent. You may withdraw from the project without penalty at anytime. No risk to the participant is expected.

The names of subject and schools will all be kept confidential and used for research purposes only.

Dr. Killian will answer any questions about the study. For questions about your rights as a subject or about injuries caused by this research, contact the Texas Tech University Institutional Review Board for Protection of Human Subjects, Office of Research Services, Texas Tech University, and Lubbock, Texas 79409. Or you can call (806) 742-3884.

Texas Tech University
School of Music
Consent Form for Research Project

Supervising Professor: Dr. Janice Killian
Janice.Killian@ttu.edu (806) 742-2270 ext 264

Researcher: Madonna Solis
madonna.solis@ttu.edu
(304)203-6717

PARTICIPANT CONSENT:

I have read the purpose, procedures, and 'respect of the individual' information given to me for the research project being conducted by Dr. Janice Killian and Madonna Solis of Texas Tech University concerning the "The Effects of Colored Paper on Musical Notation Reading on Music Students with Dyslexia."

I understand that I will be audio and video recorded during the treatments.

I understand the participation is voluntary and no monetary compensation is connected with this project.

I understand that I may withdraw from the study at any time without penalty.

I, (please print) _____would like to participate in this project.

_____ _____
Signed Date

*This consent form is no longer valid after October 28, 2010.

For questions about your rights as a subject or about injuries caused by this research, contact the Texas Institutional Review Board for Protection of Human Subjects, Office of Research Services, Texas Tech University, and Lubbock, Texas 79409. Or you can call (806) 742-3884. Dr. Janice Killian of the School of Music, can answer any questions you may have concerning this study. She can be reached at janice.killian@ttu.edu or 806.742.2270 Ext. 246.

APPENDIX C

FIRST CONTACT FACULTY RECRUITMENT E-MAIL

Dear Faculty;

My name is Madonna Solis, a graduate student in Music Education. I am currently working on my thesis studying the use of colored aids in music reading for dyslexic music students. I am contacting you asking for your help in recruiting participants.

Needed: Any music students who have ever been clinically diagnosed with dyslexia.

The participants will be asked to sight read music excerpts in twenty minutes sessions over ten days and may experience significant improvement in music reading.

Please ask your students to participate by contacting me at madonna.solis@ttu.edu

All procedures have been approved by the Institutional Review Board for Human Subjects, by my thesis committee, and by my thesis advisor, Dr. Killian.
If you would like more information, please let me know.

Thank you for your help.

Sincerely,

Madonna Solis

Madonna.solis@ttu.edu

APPENDIX D

SECOND CONTACT UNDERGRADUATE RECRUITMENT EMAIL

Please send this email to all music students.

Thanks!
Jan

Dear Students,

Please assist Madonna Solis in any way possible with identifying music students with dyslexia. She wants to assist people who are experiencing challenges in reading music notation. Her letter appears below.

Thanks!
Jan Killian

Dear Faculty,

My name is Madonna Solis, a graduate student in Music Education. I am currently working on my thesis studying the use of colored aids in music reading for dyslexic music students. I am contacting you asking for your help in recruiting participants.

Needed: Any music students who have ever been clinically diagnosed with dyslexia.

The participants will be asked to play or sing music excerpts in twenty minutes sessions over ten days and may experience significant improvement in music reading.

Curious? Please contact me at madonna.solis@ttu.edu

All procedures have been approved by the Texas Tech Institutional Review Board for Human Subjects, by my thesis committee, and by my thesis advisor, Dr. Killian.

If you would like more information, please let me know.

Thank you for your help.
Sincerely,
Madonna Solis
Madonna.solis@ttu.edu

APPENDIX E

RAW DATA

Rose Listening Results					
Treatment 1					
Session 1			Session 2		
Ex 43	Incorrect	Correct	Ex 124	Incorrect	Correct
Rhythm 15	1	14	30	7	23
Pitch 45	2	43	46	13	33
Ex 44*			Ex 59		
16	0	16	16	0	16
29	5	24	30	0	30
Ex 31			Ex 72		
36	1	35	16	5	11
39	0	39	32	10	22
180		171	170		135
Treatment 2 (Color)					
Session 3			Session 4		
Ex 141*	Incorrect	Correct	Ex 230	Incorrect	Correct
36	6	30	16	1	15
54	8	46	45	7	38
Ex 44*			Ex 208		
16	0	16	36	3	33
29	0	29	121	7	114
Ex 118			Ex 183		
48	1	47	28	1	27
60	0	60	44	2	42
243		228	290		269
Treatment 3					
Session 5			Session 6		
Ex 255	Incorrect	Correct	Ex 141*	Incorrect	Correct
9	5	4	36	10	26
35	7	28	54	8	46
Ex 288			Ex 366*		
72	6	66	32	14	18
76	10	66	101	19	82
Ex 336			EX 356		
28	0	28	32	10	22
78	3	75	74	15	59
298		267	329		253

Treatment 4 (Color)					
Session 7			Session 8		
Ex 446	Incorrect	Correct	Ex 467	Incorrect	Correct
72	20	52	32	0	32
197	48	149	57	1	56
Ex 380			Ex 458		
69	2	67	36	4	32
92	3	89	46	6	40
Ex 412			Ex 460		
48	3	45	24	0	24
86	5	81	44	0	44
564		483	239		228
Treatment 5					
Session 9			Session 10		
Ex 366*	Incorrect	Correct	Ex 507	Incorrect	Correct
32	7	25	30	6	24
101	17	84	72	10	62
Ex 425			Ex 527		
52	10	42	28	5	23
92	20	72	51	4	47
Ex 485			Ex 523		
78	10	68	22	4	18
128	33	95	32	4	28
483		386	235		202

Joe Listening Results					
Treatment 1					
Session 1			Session 2		
Ex 43	Incorrect	Correct	Ex 124	Incorrect	Correct
Rhythm 15	7	8	30	4	26
Pitch 45	2	43	46	10	36
Ex 44*			Ex 59		
16	9	7	16	1	15
29	10	19	30	2	28
Ex 31			Ex 72		
36	4	32	16	5	11
39	5	34	32	7	25
180		143	170		141
Treatment 2 (Color)					
Session 3			Session 4		
Ex 141*	Incorrect	Correct	Ex 230	Incorrect	Correct
36	3	33	16	3	13
54	7	47	45	0	45
Ex 44*			Ex 208		
16	3	13	36	0	36
29	3	26	121	7	114
Ex 118			Ex 183		
48	0	48	28	0	28
60	3	57	44	3	41
243		224	290		277
Treatment 3					
Session 5			Session 6		
Ex 255	Incorrect	Correct	Ex 141*	Incorrect	Correct
9	0	9	36	6	30
35	7	28	54	8	46
Ex 288			Ex 366*		
72	2	70	32	10	22
76	14	62	101	53	48
Ex 336			EX 356		
28	6	22	32	12	20
78	18	60	74	18	56
298		251	329		222

Treatment 4 (Color)					
Session 7			Session 8		
Ex 446	Incorrect	Correct	Ex 467	Incorrect	Correct
72	15	57	32	0	32
197	22	175	57	3	54
Ex 380			Ex 458		
69	14	55	36	12	24
92	18	74	46	13	33
Ex 412			Ex 460		
48	4	44	24	2	22
86	22	64	44	6	38
564		469	239		203
Treatment 5					
Session 9			Session 10		
Ex 366*	Incorrect	Correct	Ex 507	Incorrect	Correct
32	21	11	30	8	22
101	50	51	72	20	52
Ex 425			Ex 527		
52	10	42	28	6	22
92	23	69	51	20	31
Ex 485			Ex 523		
78	27	51	22	2	20
128	17	111	32	5	27
483		335	235		174

Chris Test results					
Treatment 1					
Session 1			Session 2		
Ex 43	Incorrect	Correct	Ex 124	Incorrect	Correct
Rhythm 15	5	10	30	0	30
Pitch 45	5	40	46	0	46
Ex 44*			Ex 59		
16	1	15	16	7	9
29	0	29	30	0	30
Ex 31			Ex 72		
36	2	34	16	0	16
39	0	39	32	0	32
180		167	170		163
Treatment 2 (Color)					
Session 3			Session 4		
Ex 141*	Incorrect	Correct	Ex 230	Incorrect	Correct
36	5	31	16	0	16
54	5	49	45	3	42
Ex 44*			Ex 208		
16	0	16	36	5	31
29	0	29	121	1	120
Ex 118			Ex 183		
48	5	43	28	3	25
60	0	60	44	4	40
243		228	290		274
Treatment 3					
Session 5			Session 6		
Ex 255	Incorrect	Correct	Ex 141*	Incorrect	Correct
9	2	7	36	6	30
35	3	32	54	8	46
Ex 288			Ex 366*		
72	14	58	32	15	17
76	2	74	101	6	95
Ex 336			EX 356		
28	11	17	32	11	21
78	29	49	74	3	71
298		237	329		280

Treatment 4 (Color)					
Session 7			Session 8		
Ex 446	Incorrect	Correct	Ex 467	Incorrect	Correct
72	8	64	32	0	32
197	23	174	57	3	54
Ex 380			Ex 458		
69	14	55	36	12	24
92	18	74	46	13	33
Ex 412			Ex 460		
48	4	44	24	2	22
86	22	64	44	6	38
564		475	239		203
Treatment 5					
Session 9			Session 10		
Ex 366*	Incorrect	Correct	Ex 507	Incorrect	Correct
32	11	21	30	8	22
101	4	97	72	20	52
Ex 425			Ex 527		
52	10	42	28	6	22
92	23	69	51	20	31
Ex 485			Ex 523		
78	27	51	22	2	20
128	17	111	32	5	27
483		391	235		174