JTML, Vol. 4, No. 1, 44-54

A COMPARISON OF THE EFFECTIVENESS OF THREE DIFFERENT TYPES OF SOFTWARE EYE-GUIDES IN THE DEVELOPMENT OF SIGHT-PLAYING SKILLS IN PIANO CLASSES AT THE COLLEGE LEVEL

Sara Hagen
Valley City State University

Cynthia Benson
Bowling Green State University

Alejandro Cremaschi
University of Colorado at Boulder

The purpose of this study was to compare three types of eye guides typically found in computer software on student sight-reading performance achievement and eye-guide preference. Three randomly selected groups of second semester students from three universities ($N = 74$) participated in the study. Participants sight-read pieces directly from the computer screen, using a computer program that featured a different eye guide in each treatment. Each treatment consisted of two 15-minute practice sessions each. A handout and a checklist guided participants through the preparation and performance periods of sight-reading. The eye-guide programs used in each stage were *Flash* animations (note-by-note guide), *Home Concert Xtreme* (highlighted the whole measure) and *Finale Performance Assessment* (sweeping thin bar). At the end of each treatment stage, participants took a sight-playing posttest that was recorded with a MIDI sequencer and later evaluated on note and rhythm accuracy by two judges. At the end of the study, participants completed an exit survey that included questions regarding their software preferences and responses to using the three different eye guides. The results indicated that all three groups improved significantly over time ($p < .0001$), although there were no significant differences between groups ($p = .43$) nor within groups ($p = .09$). The results for preference in eye guide were highest for the vertical sweep (47%), next for block highlighting by measure (31%) and the least favorite was the note-by-note guide (22%).

Introduction

The standard use of sight-reading skills in various musical settings, such as music teaching, collaborating, learning or scoping out new repertoire, auditioning, and participating in certain social and musical events reveals the importance of the development of these skills. Pianists, specifically, realize the necessity for sight-reading skills due to their involvement in these musical settings. Although music reading is a complex skill in itself, sight-reading offers a set of subskills that are distinctively different from music reading for the purpose of rehearsing for an eventual music performance (Lehmann & McArthur).

Several models have been proposed to understand the process of sight-reading. Thompson and Lehmann (2004) suggested that the process of sight-reading can be categorized as perceiving the notation, the cognitive process of the visual information, and the generation of movements. Utdaisuk (2005) proposed a model in which four main components are suggested: coordination (physical ability and coordination), musical awareness (aural, visual, and psychological), musical potential (biological and psychological), and musical experiences (interactive activities and self-directed practices). Kopiez, Weihs, Ligges, and Lee (2006) concluded that sight-reading performance is not the result of a single predictor, but of a complex interaction between predictors by examining general (nonmusic and music-specific) cognitive skills, elementary cognitive skills (e.g., psychomotor movement) and practice-related skills (expertise and auditory imagery). In an earlier examination of individual difference variables in sight-reading, Kornicke (1993) investigated sight-reading experience, aural imagery, locus of control, and personality variables and found relationships among these predictor variables.

In comparisons of expert versus novice sight-readers, better sight-readers were found to have several traits in common: (a) They did not "break down" due to rhythm or note errors (Banton, 1995); (b) they have been found to have a finer tactile sense of keyboard topography (Clifton, 1986; Harrel, 1996);(c) they used consistent fingering patterns (Sloboda, Clark, Parncutt, & Raekallio, 1998); (d) better sight-readers made greater improvement on a novel musical piece partly due to improved anticipation and wider range of planning (Drake and Palmer, 2000); and (e) expert sight-readers also attended to melodic contour and phrases, bar lines and meters, and rhythmic pulse groupings (Halsband, Binofski, & Camp, 1994; Peretz & Barbai, 1992).

Differences in eye movements (saccades) and when the eyes are relatively still (fixations) also were found between expert and novice sight-readers. Early studies found that better readers required shorter and fewer fixations, during which time information is perceived and processed along with more notes per fixation (Jacobsen, 1942; Weaver, 1943). Goolsby (1994a, 1994b) found that skilled readers fixated on blank areas of the score rather than each note. He also found that less skilled readers more likely fixated on notes and rests.

Eye-hand span refers to how far the visual system is ahead of the hands. Skilled pianists had a larger span (two beats) than less skilled pianists (half a beat) (Furneaux & Land, 1999; Gillman & Underwood, 2003). Surprisingly, skilled and less skilled sight-readers do not significantly differ in perceptual span, which is the amount of written notation extracted around the fixation point (Rayner & Pollastsek, 1997; Truitt, Clifton, Pollastsek, & Raynor, 1997; Gilman & Underwood, 2003). Yet, the fixations of good sight-readers jump around the score and expand across line and phrase boundaries, not just individual notes, suggesting that they are not just looking ahead, but ahead and back. The distance between the eyes and hands of skilled sight-readers (eye-hand span) is larger than less skilled readers (Gillman & Underwood, 2003; Goolsby, 1994a; Rayner & Pollastsek, 1997; Truitt, et al, 1997). "Generally speaking, a phenomenon of reading ahead is a behavioral consequence of a well-developed psychological readiness of the larger eye-hand span" (Udtaisuk, 2005, p. 119). The multitasking skill of sight-reading includes playing current measure, scanning the next measure, using analytical ability for memory and recall, comprehending the music, and moving fingers to find the keys without looking at the keyboard, all of which fit with the models described earlier. Eye movement not only is the result of trained eyes, but also of perceptual ability, or the ability to group notes into a meaningful pattern (Lehmann & McArthur, 2002). More experienced sight-readers remember longer sequences and can perceive multiple details of the musical score as a single piece of information than less skilled players (Goolsby, 1994; Thompson & Lehmann, 2004).

Extensive reviews of the research literature examining technology in music teaching have found results that support the effectiveness of technology (Berz & Bowman, 1994; Higgins, 1992). As reported by Hagen (2001), the computer has been used mostly as a collection device in sight-reading research rather than as a teaching aid, yet when used for teaching, computer-assisted instruction has been shown to be equal to traditional methods and possibly advantageous.

The use of technology to develop group piano student keyboard skills has been investigated. The use of digital accompaniment device and tape-recording for student practice has been investigated (Sheldon, Reese, & Grashel, 1998; Watkins, 1984). Computer software programs have also been examined for the purpose of teaching piano performance skills (Tomzcak, 1999). Benson (2002) investigated the effects between using a MIDI sequenced recording, video, multimedia computer program, and no media on group piano student performance and attitude when used in student practice. An additional aspect of this study investigated the possible effects of instructional media on student piano performance when used for in-class presentation of keyboard skills. No significant differences were found between treatment groups; however, student attitude toward the practice sessions and performance material was influenced by use of media in practice.

There have been some investigations of the use of technology to improve sight-reading skills in group piano classes. The use of MIDI accompaniment disks to develop harmonization and sight-reading skills was not found to have an effect on either of these skills, but was helpful for motivational practice (Betts and Cassidy, 2000). Hagen (2001) compared the effectiveness of three practice methods, of which two were computer-assisted, on sight-reading at the piano. One program used a play-along accompaniment practice method (*Finale*), while the other (*Harmony*) was for chord recognition practice. A third group used traditional classroom instruction. Comparing rhythm and note accuracy among the three groups, the only significant difference found was for note accuracy with the *Finale* group performing better.

As the review of literature revealed, good sight-readers' eye movements have shorter and fewer fixations and move forward and backward which is a result of perceptual ability. Less skilled sight-readers correct mistakes and have a shorter eye-hand span. Could novice sight-readers' skills be developed partly through focusing their attention (eyes) on forward movement in the score? With the development of play-along computer software programs, eye guides, whether or not for the purpose of developing sight-reading skills, can be found and are commercially available. No studies were found that compared the use of computer software programs that utilize an eye guide during playback or play-along accompaniment of a piece.

Purpose

The purpose of the present study was to compare three types of eye guides typically found in computer software on student sight-reading performance achievement and eye-guide preference.

Method

Three randomly selected groups of second semester students from three universities ($N = 74$) participated in the study. Participants worked with materials selected from Judith Wade's "Sight-Reading Exercises Level 1-8." Levels 3 through 6 were used. This book contains 8-measure pieces in different major and minor keys, grouped according to difficulty level. The pieces used in this study featured a primary chord (I and V, and I; IV and V in higher levels) in either the right or left hands, and a melody in the other hand. This melody remained in fixed 5-finger position in the easier levels, and went beyond the 5-finger position in the higher levels.

Before the treatment, participants took a placement sight-reading exam. This placement exam consisted of performing one preselected piece at sight from levels 3A, 3B and 4. These pieces were recorded using a MIDI sequencer and later evaluated by the researchers. Participants were placed in levels that presented reasonable challenges to them. Thus, if a participant performed a piece in level 3A that was mostly free of rhythmic and note errors, but had reasonable difficulties in level 3B, he or she would be placed in level 3B. All three study groups contained subjects working in all difficulty levels. Participants remained in the same difficulty level throughout the study.

After participants were placed in the appropriate level, they were given a sight-reading pretest before the first treatment. Participants were asked to record two pretest pieces with a MIDI sequencer and save them as MIDI files. These files were later evaluated by two judges to determine scores for note and rhythm accuracy. The scoring method used in the pretest evaluation also was used in the posttest scoring, and is explained below. All groups received the same three treatments, but in different order. A total of

51 participants completed all the treatments, although 74 did complete the exit survey.

During each treatment, participants sight-read pieces directly from the computer screen, using a computer program that featured a different eye guide in each treatment. Each treatment consisted of two practice sessions of 15 minutes each. During each session, participants practiced two different 8-measure pieces, for a total of four different pieces per treatment. A handout and a checklist guided participants through the preparation and performance periods of sight-reading (see Appendix). For example, this checklist reminded them to scan the piece before playing, finding key signature and time signature, accidentals, etc. Then the participants proceeded to practice by performing the entire pieces on headphones along with the computer, while the computer displayed the moving eye-guide and played back the piece. Participants were allowed multiple entire performances of the same piece, but were not allowed to change the tempo of the playback.

The eye-guide programs used in each stage were:

1. *Flash* animations. These animations were specifically created for this study. They featured a note-by-note guide. As the computer played the piece, the corresponding notes became highlighted in green.

2. *Home Concert Xtreme*. This program was used in "J" (jam) mode, which cancelled the performance following feature. This program highlighted the entire measure being played.

3. *Finale Performance Assessment*. This program featured a sweeping thin vertical bar that moved across the measure being played. The automatic evaluation features of this program were not used.

At the end of each treatment stage, participants took a sight-playing posttest that was recorded with a MIDI sequencer and later graded by two judges. Participants read two posttest pieces from paper copies, not from the computer screen. These posttest scores were used as pretest data for the next stage. Participants had a chance to "scan" each piece before recording it. The tempo was not preset for the tests; participants were allowed to choose a comfortable tempo.

At the conclusion of the study, participants completed an exit survey (See Appendix). The participants responded to questions regarding their software preferences and responses to using the three different eye guides. Table 1 summarizes the assignments of treatment groups and tests.

Note and rhythm accuracy were evaluated for each of the two pieces in each of recorded tests. Note accuracy was determined by counting wrong notes and missing notes which then were subtracted from the total number of notes in each piece. Chords were counted as one note. A percentage of correct notes was obtained for each piece. To determine rhythm accuracy, inaccurate and/or missing rhythms within a beat were subtracted from the

Table 1

Summary of Assignments of Treatments and Tests

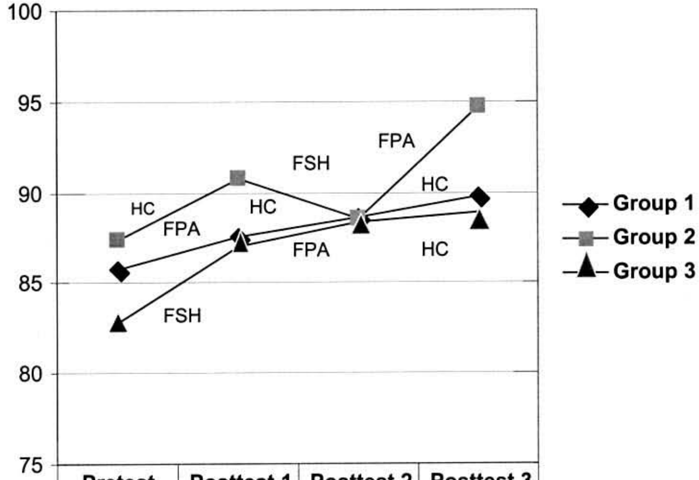
Group and # of subjects	Treatment 1		Treatment 2		Treatment 3	
Group 1 ($n = 17$)	X1	Posttest 1	X2	Posttest 2	X3	Posttest 3
Group 2 ($n = 20$)	X2	Posttest 1	X3	Posttest 2	X1	Posttest 3
Group 3 ($n = 14$)	X3	Posttest 1	X1	Posttest 2	X2	Posttest 3

Note. N = 51. Pretest was given prior to Treatment 1. X1 = practice with Flash animations; X2 = practice with *Home Concert Xtreme*; X3 = practice with *Finale Performance Assessment.*

total number of beats in each piece. Stopping and/or backtracking were counted as one rhythmic error and subtracted from the total number of beats, while pauses were counted as errors only if they were significantly long. Short pauses were not counted as errors if the performer moved forward afterward. A percentage of correct rhythms was obtained for each piece. The rhythm and note percentages for all pieces were averaged into a single score that reflected the overall accuracy of the performance for the test (arithmetic average). To find out if there were significant differences in the gains in sight-playing scores after each treatment, we ran an Analysis of Covariance (ANCOVA) using the pretest and posttest scores for each software.

Results

The purpose of this study was to compare sight-reading performances at the piano with three different eye guides and to determine preference for eye guide. Judges used in the evaluation of all tests were the researchers, colleagues, and assistants, all highly reliable, with reliability coefficients of $R = .94$ or higher for each test. In this study, all three groups improved significantly over time ($p < .0001$). There were no significant differences between groups ($p = .43$) nor within groups ($p = .09$) (see Figure 1). The results for preference in eye guide were highest for the vertical sweep (47%), next for block highlighting by measure (31%) and the least favorite was the note-by-note guide (22%).



	Pretest	Posttest 1	Posttest 2	Posttest 3
Group 1	85.76	87.52	88.58	89.76
Group 2	87.4	90.75	88.55	94.7
Group 3	82.78	87	88.35	88.92

Figure 1. Total Scores for Groups Across Study. Group 2 is highest, Group 1 is center, Group 3 is lowest.

When subjects were asked if the software affected their performance, 43 of the 47 subjects who responded indicated that it did; however, there were equal distributions for positive and negative reactions. Of those who responded positively, most appreciated the eye guide moving them forward in the music; those with negative responses commented primarily on the distractive nature of the eye guide. One respondent stated that the sweep moved the eye too far ahead, causing that subject to get lost in the music, while the note-by-note helped him/her count and the blocked highlighted measure kept the eye moving forward at about the right pace.

What some subjects regarded as strengths for the various software guides, others thought were weaknesses. For example, many subjects felt that the sweep was easy to follow and not confusing, while others stated that it was confusing, distracting, and too controlling of the tempo. The note-by note strength for many centered on its "rhythmic" quality, and the highlighted measure's strength was the ability to read the entire measure at one glance rather than having something moving.

Twenty-two of the 74 subjects (30%) indicated that they would use this software in the future. Of those who said why they would not use this software, many said that they probably would not have access to the software in the future.

Discussion

All subjects improved significantly on sight-reading over the course of the study. However, practice and regularity in training subjects to sight read probably had as much to do with the results as did the methods. One of the reasons the three software guides were chosen is their availability on the market to all piano instructors. Results are mixed as to whether or not these are effective in helping to train sight-reading. Student perceptions of the software eye guides were also quite varied and did not lead in a single direction for preference. What seems to be emerging in this research is that reading music is a complicated process that may or may not be able to be enhanced with reading guides provided by computer assisted training.

One interesting result of this study was the fact that group 2 did not follow a steady upward curve in achievement. The scores for group 2 fell after the treatment with Flash, but attained the highest scores on the third test after using the *Finale Performance Assessment* software. This result was interesting in that perhaps this software, for that group of subjects, was superior to the others and *Flash* was problematic. No significant differences were found among the groups; however, the nonlinear achievement growth pattern for this group suggests that there may be a difference. The vertical sweep in that software was preferred by 47% of the subjects in the study as well. Further study of this phenomenon perhaps would answer that question.

Several issues were raised in the course of this study. The materials used in this study contained a very limited sample of sight-reading styles, e.g., no counterpoint, only I, IV, V chords, etc. Other types of sight-reading examples could affect the outcomes, as could familiarity with key and clef reading. Further study should examine the effects of these variables in greater detail. Subjects were tested from paper rather than from the eye guide setting. Testing within the software is another step in determining whether or not the actual performance is enhanced or not. Issues of tempo also arose, i.e., should it be predetermined or should the subject be allowed to choose the tempo? Future studies should test both assumptions. In addition, studying the effects of the computer environments only for practice, with testing being completed in a "natural" paper setting may also shed some light on whether or not the software is effective as a training device.

The next study planned by this group of researchers will include a control group, longer periods of time on the software, the use of the software for practice only, and an exit survey with more specific questions on preference.

References

Banton, L. (1995). The role of visual and auditory feedback during the sight-reading of music. *Psychology of Music, 23*(1), 3-16.

Benson, C. (2002). The effects of instructional media on group piano student performance and attitude. *Journal of Technology in Music Learning, 1*, 38-55.

Berz, W. L., & Bowman, J. (1994). *Applications of research in music technology*. Reston, VA: Music Educators National Conference.

Betts, S., & Cassidy, J. (2000). Development of harmonization and sight-reading skills among university class piano students. *Journal of Research in Music Education 48*(2), 151-161.

Clifton, J. V. (1986). Cognitive components in music reading and sight-reading performance. *Dissertation Abstracts International,* 47-05, 2203B.

Drake, C., & Palmer, C. (2000). Skill acquisition in music performance: Relations between planning and temporal control. *Cognition, 74*(January 2000), 1-32.

Furneaux, S., & Land, M. (1999). The effects of skill on the eye-hand span during musical sight-reading. *Proceedings of the Royal Society of London-Biological Sciences, 266*(1436), 2435-2440.

Gilman, E., & Underwood, G. (2003). Restricting the field of view to investigate the perceptual spans of pianists. *Visual Cognition, 10*(2), 201-232.

Goolsby, T. (1994). Profiles of processing: Eye-movements during sight-reading. *Music Perception, 12*, 77-123.

Hagen, S. (2001). The effects of computer-assisted instruction and cognitive style on sight playing among university group piano students. *Dissertation Abstracts International, 62,* 1767A. (UMI 3016045).

Halsband, U., Binkofski, F., & Camp, M. (1994). The role of the perception of rhythmic grouping in musical performance: Evidence form motor-skill development in piano playing. *Music Perception, 11,* 265-288.

Harrel, R. (1996, February). Components of sight-reading. *Clavier, 35,* 25-27.

Higgins, W. R. (1992). Technology. In *Handbook of Research on Music Teaching and Learning,* Richard Colwell (Ed.), New York: Schirmer Books, pp. 480-497.

Jacobson, O. I. (1942). An analytical study of eye-movements in reading vocal and instrumental music. *Journal of Musicology, 3,* 197-221, 223-266.

Kopiez, R., Weihs, C., Ligges, U., & Lee, J (2006). Classification of high and low achievers in a music sight-reading task. *Psychology of Music, 34*(1), 5-26.

Kornicke, L. E. (1993). An exploratory study of individual difference variables in piano sight-reading achievement. *Dissertation Abstracts International* 53: 4125A.

Lehmann, A., & McArthur, V. (2002). Sight-Reading. In Richard Parncutt and Gary McPherson, *The Science and psychology of music performance: Creative strategies for teaching and learning*, (pp, 135-150). Oxford: University Press.

Lyke, J. (1996). The adult in a college piano lab. In J. Lyke, Y. Enoch, & G. Haydon (Eds.), *Creative piano teaching* (3rd ed., pp. 415-422). Champaign, IL: Stipes Publishing L.L.C.

Peretz, I., & Barbai, M. (1992). The role of contour and intervals in the recognition of melody parts: Evidence from cerebral asymmetries in musicians. *Neuropsychologia, 30,* 277-292.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin, 124*(3), 372-422.

Rayner, K., & Pollastsek, A. (1997). Eye movements, the eye-hand span, and the perceptual span during sight-reading of music. *Current Directions in Psychological Science, 6*(2), 49-53.

Sheldon, D., Reese, S., & Grashel, J. (1999). The effects of live accompaniment, intelligent digital accompaniment, and no accompaniment on musicians' performance quality. *Journal of Research in Music Education, 47*(3), 251-265.

Skroch, D. (1991). A descriptive and interpretive study of class piano instruction in four-year colleges and universities accredited by the National Association of Schools of Music with a profile of the class piano instructor. *Dissertation Abstracts International,* 52/11, 3854.

Sloboda, J. A., Clarke, E. F., Parncutt, R., & Raekallio, M. (1978). Determinants of finger choice in piano sight-reading. *Journal of Experimental Psychology: Human Perception & Performance, 24*(1), 185-203.

Thompson, S., & Lehmann, A. (2004). Strategies for sight-reading and improvising music. In Aaron Williamon (Ed.), *Musical Excellence: Strategies and techniques to enhance performance* (pp. 143-159). Oxford: University Press.

Tomczak, L. (1999). The evaluation of two self-instruction learning approaches assessing music knowledge and simple music keyboard performance skills. *Dissertation Abstracts International, 60,* 3263.

Truitt, F., Clifton, Jr., C, Pollastszek, A., & Rayner, K. (1997). The perceptual span and eye-hand span in sight reading music. *Visual Cognition, 4*(2), 143-161.

Udtaisuk, D. (2005). A theoretical model of piano sightplaying component. (Doctoral dissertation, University of Missouri-Columbia). *Dissertation Abstracts International*, A 67/01.

Wade, Judith. (2002). *Sight-Reading Exercises. Levels 1-8*. Orchard Lake Music School.

Waters, A., & Underwood, G. (1998). Eye movement in a simple music reading task: A study of expert and novice musicians. *Psychology of Music, 26*, 46-60.

Watkins, A. (1984). The effect of the use of a recorded soloist as an aid to be teaching of sight-reading accompaniments at the piano. *Dissertation Abstracts International, 45*(06A), 1679.

Weaver, H. E. (1943). A survey of visual processes in reading differently constructed musical selections. *Psychological Monographs, 55*(1), 1-30.

Wristen, B. (2005). Cognition and motor execution in piano sight-reading: A review of Literature. *Update, 24*(1), 44-55.

Appendix

Exit Survey for Subjects in Eye Guide Preference Study

Complete this grid with comments regarding each eye guide: What did you like or dislike about each style? List as many ideas as you can. *Please indicate the order in which you performed at each software station.*

Type of eye guide	**Likes**	**Dislikes**
Vertical line sweep (*Finale*)		
Highlighted measure (colored) (*Home Concert 2000*)		
Note-by-note (*Band in a Box*)		

1. Which of the eye guidance presentations did you prefer? Select one only.
   _____Sweeping red line
   _____Colored highlighted measure
   _____Note-by-note highlight

2. Do you think any of the guidance methods affected your performance?
   _____Yes
   _____No

If so, how?

3. Have you performed from computer screen notation prior to this experience?
   _____Yes
   _____No **If no, skip to question 6.**

4. How often do you perform from musical notation on a computer screen?
   _____Once a day
   _____Once a week
   _____Once a month
   _____Only on rare occasions

5. For what purpose(s) do you read musical notation from the computer?

6. Do you think you will use the computer for musical reading more or less often in the future?
   _____Yes
   _____No

   Why or why not?