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THE EFFECTS OF COMPUTER ASSISTED INSTRUCTION AND COGNITIVE STYLE ON SIGHT PLAYING AMONG UNIVERSITY GROUP PIANO STUDENTS

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The purpose of this study was to investigate the effectiveness of two different computer assisted practice methods, a traditional classroom method, cognitive style (field dependence/independence), and gender on the ability to sight play at the piano in second year group piano classes at a large southern university. Due to subject attrition, comparisons of groups were not reported; however, a *t* test revealed significant improvement from pretest to posttest for the three practice method groups, regardless of practice method or cognitive style. Subjects ($N = 40$) ranked their sight playing ability, accompanying experience, and the importance of sight playing to their future work. Preview protocols were examined to explore possible connections between how subjects prepared to sight play and their sight playing scores. Subjects in the computer groups were surveyed for attitude and experience with computers. Two-thirds of the subjects in the computer groups believed the computer improved their sight playing.

Most music educators will agree that piano sight reading skills, or more specifically "sight playing" skills, are an important aspect of the undergraduate preparation for any musical career. Therefore, functional piano skills are a main priority in the curriculum (Betts & Cassidy, 2000; Skroch, 1991). Widen (1999) found that educational technologies are being used to teach these skills in college group piano courses and that the use of these technologies has been shown to increase student motivation and persistence in learning.

Evidence suggests that many researchers are interested in sight reading development, as witnessed by the number of studies in various fields such as music education and psychology. Music education literature tends to focus on comparing various methods for achievement in reading (Anderson, 1981; Barry, 1990; Coffman, 1990; Grutzmacher, 1987; Salzberg & Wang, 1989) or identifying factors affecting sight reading (Cox, 2000; Lehmann & Ericsson, 1993; McPherson, 1994; Scripp, 1995; Waters, Townsend, & Underwood, 1998). Other studies have investigated the relationships among aural awareness, error detection and sight reading ability (Bozone, 1986; Kostka, 2000). Teaching rhythmic patterns and kinesthetic responses have been examined (Rogers, 1996; Stegall, 1992) as well as utilizing preliminary studies of scores using various methods prior to reading (Coffman, 1990; Kostka, 1997). Working with a digital accompaniment system has been found to be less tedious than other methods and a more enjoyable means of practice (Sheldon, Reese, & Grashel, 1999).

Psychological research has investigated the effects of cognitive style as a factor of musical sight reading skills (Barry, 1990; Craig, 1982; King, 1983; Kornicke, 1992; Mason, 1991).

Finally, another area of significant research in psychology is that of eye movement as it relates to musical sight reading ability (Goolsby, 1989; Kinsler & Carpenter, 1995; Lannert & Ullman, 1945; Rayner, 1998; Savler, 1945). Sloboda's work with others in perception is exhaustive in the area of music reading (Sloboda, 1976, 1977, 1978, 1984; Sloboda, Davidson, Howe, & Moore, 1996; Sloboda, Clarke, Parncutt, & Raekallio, 1998).

The use of technology in music skills acquisition has also been studied (Bowman, 1984; Ester, 1997; Fortney, 1995). However, Higgins (1992) listed areas of importance rarely reported in technology research as it relates to music acquisition skills, such as "(1) the specific features of the technology that influenced learning, (2) the design elements of the materials and the pedagogical basis for their choice, and (3) types of learners that respond to various aspects of mediated instruction" (p. 491).

Purpose of the Study

The purpose of this study was to investigate the effects of cognitive style, represented by field dependence/independence (FDI), and gender on the ability to sight play at the piano, in computerized and traditional practice environments. FDI is characterized by the manner in which the learner visually perceives the surrounding world. These constructs have been labeled "global vs. analytical" or "differentiation," first suggested in 1954, by Witkin and others (Witkin & Goodenough, 1981). Field independence has been linked to higher achievement as well as to better reading abilities in music (Barry, 1990; Bush, 2000; Ellis, 1995; Kornicke, 1992; Tinajero & Paramo, 1997; Widen, 1999), although not all studies have shown relationships between FDI and various musical tasks (Craig, 1982; Huang, 1982; Mason, 1991). Further, the verbal protocols and weekly self-evaluations of subjects were investigated for possible relationships between preparation and actual performance. Attitudes about sight playing and previous experiences might also play a role in the ability to sight play and were included for exploratory purposes.

Research Questions

The following research questions were developed for this study:

1. Are there significant differences in student pianists' sight playing scores as a function of the three different teaching methods?

2. Are there significant differences in student pianists' sight playing scores as a function of field-dependence or field-independence cognitive style?

3. Are there interactions among the methods of practice and cognitive style on the sight playing scores of student pianists?

4. Are there relationships between previewing behavior as measured by verbal protocol analysis and sight playing?

5. Are there relationships between gender, years of piano lesson experience, years of accompanying experience, attitudes toward sight playing, or attitudes toward computer assisted instruction and student pianists' sight playing scores?

The dependent variable of a final score on two sight playing examples was addressed relative to the following independent variables: practice technique, FDI, gender, major instrument, previous piano experience, computer and sight playing attitudes. To test the effectiveness of instructional methods for sight playing, a pretest-posttest design was created for the three practice method groups with subjects randomly assigned to the groups according to cognitive style.

Method and Procedure

Five second-year group piano classes from a large southern university were chosen for this study. A total of 59 subjects volunteered; however, due to various circumstances, the final *N* was 40.

Individual differences in cognitive style were determined on the basis of the *Group Embedded Figures Test* (GEFT, Witkin et al, 1971) to determine the relative field dependence/independence (FD/FI) of the subjects. The GEFT is a paper and pencil test that requires the respondent to locate simple figures within more complex visual fields. The total score is the number of simple figures correctly traced in 18 examples (0-18). The score is placed within a continuum on which the subject is considered to be more FD (lower scores) or more FI (higher scores). Witkin, Oltman, Raskin, & Karp (1971) reported statistical validity scores of .82 for males and .63 for females using factor analysis and correlation studies.

The GEFT test was administered to the volunteers, and then the subjects were randomly assigned to one of three groups–computer 1, computer 2, or classroom. To ensure an even distribution of FDI scores, the original 59 scores were listed in descending order across the three groups with subjects matching those scores being assigned from each of the five sections. The researcher assigned even numbers of males and females to each group on a random basis as well. In addition, the mean GEFT score was very close for each group with 13.80 for the computer 1 group, 13.40 for the computer 2 group, and 13.95 for the classroom group. The original groupings also had 12 females and 8 males in each (11 females in the classroom group) for an *N* of 59.

The pretest musical examples were chosen for their pedagogical match to the outcome desired for the course. To control for possible order effects, the pieces were presented in opposite order for each subsequent subject. The subjects were asked to talk aloud for two minutes as they mentally prepared to play the first piece. They were given a practice piece to talk about as a warm up. The following instructions were read to each subject prior to the verbal "talk aloud" session.

> I am going to present you with a piece of music that I would like you to sight read. I will give you two minutes to preview this piece, during which time I would like you to think aloud, telling me where and what you are looking at in the music. The most important thing to remember in this experiment is to think aloud and keep talking. If you do stop talking I will remind you to continue.

During the preview sessions, subjects were reminded to continue speaking after a few seconds of silence with the statement, "Please keep talking." Immediately following the verbal protocol, the subjects played the piece, repeating the process for the second musical example.

Several aspects of related literature studies were incorporated into the research design for sight playing practice. All groups practiced sight playing for 20 minutes per week (Betts & Cassidy, 2000). Field dependent learners tend to prefer a structured environment and global visual patterns, so practicing chord patterns with instant feedback that provided detailed information about errors was incorporated

Subjects in the Computer 2 group practiced 10 to 12 minutes per week with *Harmony* by *Musicware, Inc.*, a highly structured software program that supports bottom-up automation of motor skills as well as top-down content knowledge, including practice with regular chord analysis, chords and inversions using correct fingerings, and bass clef reading (Lowder, 1973.) In the *Reading* mode of the software, two-voice intervals in treble and bass clef move to root position chords in both clefs, followed by inversion in all keys and then progressing right hand chords in the treble clef against a single voice left hand in the bass clef. These subjects also played through the two weekly sight playing examples after computer practice on their own.

Using Finale, subjects in Computer 1 group practiced the weekly examples (MIDI files). This software was used to target the practice of absolute rhythmic evenness, even at the occasional expense of note accuracy (Drake & Palmer, 2000; Kostka, 2000; Lehmann & Erricson, 1993; Lowder, 1973). *Finale* guides the eye forward in a smooth tracking function (Picking, 1997) and forces a steady beat in an accompaniment-style manner. From the eye movement studies, it was apparent that training the eye to continue forward (to avoid getting "stuck") might be helpful to some sight players.

The weekly sight playing materials were extracted from various group piano methods and supplementary books other than those currently used in

the curriculum, chosen by the researcher, group piano instructors, and chair of piano pedagogy (e.g., three-voice treble clef against a single-voice bass clef in both duple and triple meters with simple quarter, half, and whole note rhythms within one key of C Major and A minor, (F major and D minor, or G major and E minor).

Subjects were instructed in sight playing using the strategies as outlined in the curriculum. Before and after each practice period, subjects completed a checklist, including a preview checklist and an assessment of their performance, applying Scripp's (1995) finding that reflection is important for growth in music reading.

The subjects who had completed at least 80% of the treatments completed the posttest during the final two weeks of the semester, following the same procedure as in the pretest. In addition, subjects completed the surveys of piano experience and computer attitudes and a posttest interview with the researcher.

The researcher scored all pretests and posttests using a method that counted correct notes and rhythms only. If there was an error in the note anywhere within a beat on which the notes were attacked, it was marked as an incorrect beat for notes. The rhythm was scored according to its relative position in the measure. In other words, if the subject lost the tempo, but regained the pulse, the subsequent beats were considered to be correct. If the attack was late or early, it was marked as a rhythm error per attack. Notes held for longer durations were not marked beyond the first attack. All raw scores were converted to the percentage of the total possible for final analysis. The correct note and rhythm scores on each piece were also independently recorded for each subject for analysis. Three independent judges scored a randomly selected 25% of the tests in order to verify the reliability of the scoring method. Judges were experienced in teaching group piano and were given several practice examples followed by discussion in order to come to a consensus in scoring.

Results

The purpose of this experiment was to examine the effects of practice methods as a function of cognitive style and gender for instruction in sight playing in the university group piano class. Aspects of attitude and experience were also explored as possible factors in the individual's performance in sight playing as were analyses of processes in preparation for sight playing, collected through verbal protocols. The design of the study was a 3 x 2 x 2 factorial analysis of covariance (ANCOVA). The design of the study sought a large effect size with an alpha level of .05 and a power of .80. To accomplish this, an N of 60 is required; however, due to a variety of reasons, that number was not met. Forty ($N = 40$) subjects completed the study (28 females and 12 males). As a result, the first three research questions were eliminated from the study. Research questions four and five were examined, as well as a comparison of pretest/posttest sight playing scores and a

report of GEFT scores. Interjudge reliabilities for correct notes and rhythms were calculated using the Kuder-Richardson test. High positive correlations were consistently found for both note and rhythm error detection.

A paired *t* test was run using the SPSS statistics program with pretest and posttest scores of the total sample to determine overall growth in sight playing ability. A significant difference was found between the two scores ($p < .001$). Note accuracy and rhythm accuracy scores for pretest and posttest were also paired and a significant difference was found for both scores ($p < .01$).

The *Group Embedded Figures Test* (GEFT) was administered to assess the subjects' levels of field dependence/independence (FDI). The grand mean of all subjects ($N = 40$) was 14.83, with a median of 16 (18 is a perfect score). Forty percent of the subjects scored a 17 or 18 on the test. These results are well above the published averages in the test manual and similar to the findings of Mason (1995) with college-age music majors (mean of 14.92). For their college-age subjects, Witkin et al. (1971) reported means of 12.0 for males and 10.8 for females. The current study found means of 14.0 for males and 15.2 for females; however, males consistently scored higher than females in all domains across the literature. Two FDI groups were created from the mean of 14.83 for purposes of analysis. Those subjects who scored below 15 were placed in the low group and those above 15 were placed in the high group. Because the scores were skewed to field independence, and there were so few low scores, it was decided to use this cut-point procedure (e.g., Luk, 1998).

Research question four explored possible relationships between previewing behavior as measured by verbal protocol analysis and sight playing. Transcriptions of the talk-aloud sessions were made and analyzed by the researcher by encoding the statements into eight categories–temporal features (e.g., tempo, rhythm, and meter, etc.), note features (e.g., key and accidentals), motor skill features (e.g., fingerings), surface features (e.g., dynamics), deep structural features (e.g., modulations, sequences, chordal patterns), representational modes ("hearing in their head," visualizing the keys, singing, or other internal method), cognitions (comments regarding ability, reminders, and intentions related to performance), and other features which did not fit any of the above categories (e.g., nonsense phrases, off-task comments). The encoding and collecting of judges' scores for inter-reliability was done with the computer program MPAS (Mini-Protocol Analysis System, http://plaza.ufl.edu/delaney/mpas/mpas.html).

The researcher utilized one of the judges from the sight playing tests to verify the reliability of the scoring method by scoring a randomly selected group of 25% of the protocols. The pretest reliability was .72 and the posttest reliability was .83, calculated using the Kuder-Richardson test.

Crosstabs and Pearson correlations were used to examine various aspects of the previewing behaviors and the composite accuracy scores for both pretests and posttests. Significant relationships were not found between the number of remarks made during the protocol session and the

composite accuracy scores; however, the number of remarks was highly correlated to those for each of the examples ($p < .01$). In other words, the subjects tended to verbalize the same number of ideas for each of the two-minute preview sessions for both pretest and posttest protocols with an average of 12 remarks. The protocols then were examined by subdivisions within each category. One significant correlation was found between the category 3b (identifying hand shifts) and posttest composite scores ($p < .05$). A significant relationship also was found between category 3a, identifying fingering preparations, and 3b ($p < .05$). The relationship between these two factors is not surprising, given that they both deal with the concept of motor skills. The number of verbalizations regarding fingering increased from pretest to posttest, though not significantly. However, the awareness of fingering patterns may be linked to higher posttest scores. Those subjects who mentioned fingering also mentioned the awareness of hand position shifts as well. In addition, a paired t test run for each of the categories in the protocol analysis from pretest to posttest found one to be significantly different ($p < .01$), category 7b (reminders for performance such as "I have to remember the F sharps").

Research question number five explored relationships between gender, years of piano lesson experience, years of accompanying experience, attitudes toward sight playing, and attitudes toward computer assisted instruction and student pianists' sight playing scores. An ANCOVA was run with gender and composite posttest scores, controlling for the pretest, and a significant difference was found, $F(1, 38) = 5.844$, MSE = .09493, $p < .05$. The mean for males was .76 compared to .87 for females. The observed power was .654 with an eta squared of .133, a fairly small effect size. This model had an R squared value of .847 and was adjusted to .829, indicating a fairly substantial amount of variance in posttest scores due to gender. In a post hoc examination of the top 17 achievers (those improving 10 percentage points or more), 75% were males. In this particular sample, then, the males improved more than the females on sight playing. Males also had more room for improvement from the beginning to the end of the semester. In a one-way ANOVA comparison of males and females from pretest to posttest, significant differences were found on each, though the gap closed slightly on the posttest (males, $F[1, 38] = 7.957$, MSE = 0.185, $p < .01$; females, $F[1, 38] = 5.844$, MSE = .09493, $p < .05$). Males had a greater diversity of performance across groups than did females, with males performing the best in the computer 1 group, next in the computer 2 group and last in the classroom group.

An examination was made regarding possible relationships between past experiences with piano lessons, the number of years of lessons, and major instrument and sight playing ability. Twenty-six of the 40 subjects had piano lessons prior to college, with an average of 3.16 years and an average break between lessons of 3.41 years. Twenty-three subjects were instrumentalists and 17 were vocal majors. Several significant relationships emerged from the data. First, gender was a significant factor in previ-

ous piano lessons and years ($p < .05$). Females were more likely to have had previous piano lessons and had taken lessons for longer periods of time. All males were instrumental majors and only 4 of the 12 males in the study had previously taken piano lessons. Previous piano lesson experience and the number of years of study were highly related to composite scores on the posttest ($p < .01$). Years between lessons were not significantly related to the posttest scores, however.

Only six of the subjects had previous accompanying experience. However, a significant correlation ($p < .05$) was found between previous accompanying experience and posttest composite scores. No other significant differences were found. Significant relationships were not found between self ratings of sight playing ability and posttest scores. The mean for self ratings on a scale of 1 to 10 for males was 4.92 compared to 5.75 for females, also not significant. A significant relationship was not found between their ratings of the importance of sight playing and their own sight playing ability ratings or their posttest scores. Subjects rated the importance of the ability to sight play fairly high, with a mean of 7.66. The majority of the subjects felt that sight playing at the piano would be important in their future work as musicians.

Ninety two percent of the subjects in the computer groups strongly agreed or agreed with the statement "I use computers daily." This finding more than likely eliminated any novelty effect of computer usage, even though the actual software or procedures may have been new to them. Eighty-eight percent of the subjects reported feeling comfortable with the computers in this study. Fifty-six percent (14) of these subjects had used computers for practicing skills related to music in other classes, such as in the introductory music technology class, world music cultures, ear training, and composition. Only three subjects in the computer groups disagreed or strongly disagreed with the statement "I was comfortable using the computer in this study." One reason given for discomfort was the awkwardness of the lab setup. Sixty percent of the subjects strongly agreed or agreed with the statement, "I believe the computer program helped my sight playing ability as a result of this study." Significant correlations were not found between group assignment and belief in effectiveness, or with any of the independent variables listed on the survey. The only significant relationship found among the variables of computer attitude and experience was that of experience with computers in other classes ($p < .05$). Finally, 32% of the subjects in the computer groups believed they would use computers in the future to practice skills independently as a result of this study. Forty percent believed that they would not independently practice music skills on the computer in the future and the remaining 28% reported a neutral response to the question.

Discussion and Conclusions

As the full factorial model was disregarded due to lack of subjects, research questions one through three were eliminated from the study. One of the main problems with the study was lack of attendance at class, which then skewed the FDI mean. Subjects were given the opportunity to drop their lowest grade if they had perfect attendance on the days the experimental treatments were given; however, even with that incentive, subjects still failed to attend class. There were more dropouts in the study from the groups at the beginning and end of the school day (8.00 a.m. and 5:45 p.m.), thus suggesting that those times are not as successful for piano study as those scheduled in the middle of the day (11:15 a.m. and 12:20 p.m.). Interestingly, 50% of the males compared to 20% of the females dropped out of the study. Also, attrition might be linked to cognitive style. The FDI averages for the final posttest groups were 14.43 for the computer 1 group, up slightly from the original group of 13.80; the computer 2 average GEFT rose from 13.40 to 16.36; and the classroom group rose from 13.95 to 14.07. Eight of the subjects scoring 11 or lower dropped out of the study, constituting 75% of the FD population and 42% of the total dropouts in this sample. This left only four subjects with scores of 11 or below in the entire sample. Hardest hit by this attrition rate was the computer 2 group with the lowest score of 13. Out of that group alone, GEFT scores of 0, 5, 6, 10, and 11 were dropped. Three of those five subjects were in the early or late class sections, which may account for some of the absences. Offering meaningful incentives may help with this challenge in future research studies. These results suggest that FD males may need additional attention in the classroom.

Significant growth across the sample, regardless of practice method or cognitive style, suggests that sight playing can be improved with practice. Most subjects agreed that practice was the key reason for their perceived improvement. Significant increases were found from pretest to posttest verbal protocols in the cognitive areas, particularly those related to reminders, fingering and hand shifts. For example, the posttest protocols were more procedural in nature, with more consistent mention of key and meter markings. The implementation of consistent procedures may have been the most effective strategy for subjects in this study. Evidence of this conclusion was supported by the interviews of subjects following the posttests. One subject said, "The checklist made you think about your mistakes and think about ways to fix them [and to] notice trends and bad habits." Another subject said that she now takes "the time to look at everything and it takes away a lot of little mistakes I used to make." One subject suggested that the order and difficulty of skills presented might have had a role in his improvement of sight playing ability, an area for future research.

Nearly two thirds of the subjects in the computer groups agreed that the computer helped their sight playing skills. Only about one third plans to use the computer on their own volition to practice musical skills in the future,

however. Perception of improvement due to any practice method is helpful when motivating students; therefore, computer assisted instruction has a place in the pedagogies of group piano at the university level.

Future research regarding field dependent/independent tendencies of music majors would also be of interest. Psychological profiles, including learning styles of college-age music students might help instructors create more effective individualized learning environments.

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