

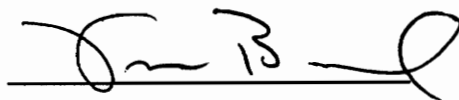
The Effect of Left-Hand Training
on Piano Performance

by
Carl Prescott Humphries

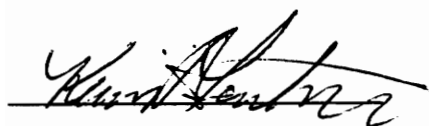
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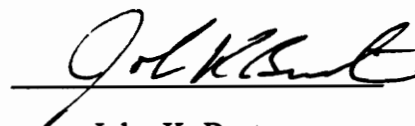
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THE EFFECT OF LEFT-HAND TRAINING ON PIANO PERFORMANCE

by

Carl Prescott Humphries

Dr. C. Vernon Burnsed, Chairman

(ABSTRACT)

The purpose of this study was to determine the effects of left-hand training on piano performance among college students with no piano background. A pilot study and an expanded study were conducted over a two year period. Volunteers for each study were randomly assigned to either a control group or a treatment group. The control group was instructed in the traditional manner, using simple melodies in the right hand and chordal figures in the left hand. The treatment group, however, was instructed using simple melodies in the left hand and chordal figures in the right hand. At the end of the training period, a posttest was given.

The areas tested included "Pitch Accuracy in the Left Hand," "Pitch Accuracy in the Right Hand," "Rhythmic Accuracy in the Left Hand," "Rhythmic Accuracy in the Right Hand," and "Overall Technical Proficiency." The results of both studies consistently showed significantly improved playing skills in the treatment group.

Future experimental research was recommended. This should include an extended training period, larger sample size, different age groups, different socioeconomic backgrounds, and different preferred hands.

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Introduction

Many college piano faculty and other accomplished pianists will openly agree that the left hand is usually technically "weaker" than the right (Edel, 1986). Quite often, the left hand seems slower than the right hand (Oldfield, 1970). In addition, accuracy in the left hand appears lacking when compared to accuracy in the right hand. Only in the case of left-handed pianists does the playing performance between left hand and right hand appear somewhat more balanced, though many left-handed pianists admit to slower left-hand responses. Wiley (1996) asserts that most pianists, whether right-handed or left-handed, pay more attention to passages for the right hand. This is most likely the predominant reason for a lack of accuracy with the left hand. With better left-hand preparation in the early stages of piano training, left-hand proficiency may be improved.

Theodore Edel supports the idea of improved early left-hand preparation. He believes that the "the surest route to a first-class technique is through music for the left hand alone, because it forces us to focus our complete attention on that hand and everything it does" (Edel, 1986, p. 12). With approximately 1,000 pieces available for the left hand alone, there is certainly no shortage of pieces on which to train students.

Composers of piano literature have been writing pieces for the left hand for over 100 years (Edel, 1986). These pieces were written for a variety of reasons. Some were written for didactic purposes, or even for pure showmanship. Others were written due to an injury to the right hand of the composer or a colleague's. For example, the renowned concert pianist/teacher Leon Fleisher is no longer able to use his right hand due to an injury, thus forcing him to concentrate on his left-hand performance skills. Interestingly, he has developed an unusual ability to perform works with his left hand that were written for the right hand (Montparker, 1986).

With the numerous left-hand pieces available, it seems unusual that so many theories, books, and articles written about piano technique barely mention, if at all, technique and training for the left hand. Most of them completely fail to give any suggestions for the training of the technically weaker left hand. Perhaps one reason for the lack of supportive left-hand training literature is that many historical and modern professional pianists disagree on issues related to both training and handedness in general.

Mozart saw a difference in the functioning of the two hands during performances. Gerig (1974) mentions that Mozart once wrote that his audiences could not understand why the left hand should keep strict time during certain rubato passages while the right hand slowed down. Mozart strongly felt that "each hand should be properly trained" (Gerig, 1974, p. 54), and even indicated that one of his contemporaries, Muzio Clementi, had great facility with his right hand, but lacked this facility in the left hand, thus making his playing unmusical and mechanical. Mozart also remarked that the problem that Clementi faced did not improve over time. In that historical setting, pianists were aware of, and critical of, problems associated with left-hand training and ability.

Modern professionals are just as passionate in their approaches to left-hand problems. Notable piano pedagogists such as Victor Seroff and Ruth Slenczenska have constructed pedagogical materials from which students can choose, as well as given exhaustive instructions on how to physically approach the art of piano playing. Their approaches to left-hand training differ.

Seroff (1970) believes that the piano is built as an instrument for the left hand, and that the left hand can play both melody and harmony simultaneously due to the physical design of the left hand. Seroff concludes that works for the right hand have not been written for the aforementioned reasons. During private lessons with Slenczenska,

she stressed the importance of a properly trained left hand. In her book, "Music at Your Fingertips" (1968) she states that, while practicing, a pianist should look at the weaker hand. In other words, the pianist should look at the right hand if left-handed, and look at the left hand if right-handed. Slenczenska distinctly brings the issue of dominant handedness into the training approach.

Pickard (1986), also feels that handedness is an important issue in piano performance. Contrary to Seroff (1970), she states that the piano is physically a right-handed instrument, considering that most music written for it favors the right hand. She also indicates that traditional piano instruction is geared towards the brain organization patterns of the right-handed. Fadely and Hosler (1983) support her premise, implying that left-handers learn a motor control operating procedure of right to left. The piano, in contrast, due in part to the literature, requires a left to right relationship.

Research into the dominant handedness issue in left-hand piano performance does not support Pickard's ideas. Left-handers have been found to have an advantage over right-handers in motor speed skills (Annette, 1983; Flowers, 1975). There is evidence to suggest that left-handers have better motor control over their nonpreferred hand than do right-handers (Peters & Durdin, 1979; Annette, 1983). In addition, there is evidence that left-handers are more musical than their right-handed counterparts (Annette, 1985; Barsley, 1966).

Oldfield (1969) found that a high percentage of college music staff had left-hand tendencies. Byrne (1974) found that there was a preponderance of mixed-handers among instrumentalists. Further research suggests that mixed-handers with stronger left-hand tendencies made fewer errors on a test of pitch identification (Deutsch 1978, 1980). Finally, Craig (1980) found that left-handers were superior to right-handers in identifying

rhythms. These studies suggest that not only does handedness effect piano performance, but that left-handers have musical advantages over right-handers.

Studies in the field of bilateral transfer have yielded some interesting results that may have applications to left-hand piano performance. For instance, Puretz (1983) found that complex movements should be taught from the nonpreferred side to the preferred side of the body. Furthermore, Hicks (1974) concluded that left-handed practice benefited right-handed performance more than right-handed practice benefited left-hand performance of a writing-skill task. These studies suggest that vigorous left-hand training may benefit pianists in overall performance levels.

Still, other modern professionals do not emphasize dominant handedness or bilateral transfer when considering piano performance. Freidberg's (1993) approach concerns less technical aspects of piano teaching. She stresses that a synthesis of all the body's natural movements and functions will create the best performances.

Uszler (1992) also describes many approaches to the study and research of piano teaching. These approaches range from the time honored "middle-C" approach to modern awareness/synthesis techniques. Uszler believes research in group teaching and technology should be conducted. Unfortunately, little research has been conducted on the left hand in piano performance.

While Brown (1928) believed that musicians are generally not interested in the psychology of learning, Uszler (1992) disagrees. As Brown stated, "They [musicians] are often content to let habits and intuition sway without considering the possibility that principles formulated in other fields may be valuable in learning music" (Brown, 1928, p. 235), Uszler believes that much new piano research is leading in new and evolutionary directions. This research may lead to discoveries concerning the left hand and piano performance.

It seems reasonable to suggest that improvement in left-hand playing may positively affect overall performance levels of both left-handed and right-handed pianists. Vigorous training in left-hand playing at the early learning stage of development may contribute to better developed left-hand skills and improved overall proficiency.

Taylor (1994) admits that traditional teaching has sometimes fallen short of fully preparing pianists. Slenczenska (1968) believes that no individual or book has all the answers to pianistic problems, whether a specific technical problem or a mental preparation paradigm. This study does not attempt to address the multi-faceted problems that pianists face. Rather, this study proposes to improve upon the teaching of piano by exploring the relationship between an improved left-hand preparation at the early stage of piano training and piano performance in college-age adults.

The opinions of professional pianists, as well as the aforementioned research, lead to the following question: What is the effect of left-hand training on piano performance?

Definition of Terms

For the purposes of this study, the identification of the following terms is intended to provide clarity for the reader.

Asymmetry, a greater amount of bilateral transfer occurring from one limb to the other (Magill, 1989, p.387)

Bilateral transfer, the ability to learn a particular skill more easily with one hand or foot after the skill has been learned with the opposite hand or foot (Magill, 1989, p.386)

Dextrality, the predominant use of the right hand for unilateral skills (Oxendine, 1984, p.362)

Dichotic listening tasks. the playing of different messages in each ear simultaneously, usually from a two-channel tape recorder through headphones (Annette, 1985, p.110)

Handedness and preferred hand. the hand that an individual chooses to use on a majority of hand activities (Coren, 1992, p.38)

Lateral dominance. the habitual use, in unilateral motor tasks, of one hand, foot, or eye in preference to the opposite member (Oxendine, 1984, p.362)

Mixed-handedness. those individuals who show only a moderate or weak preference for one hand over the other (Coren, 1992, p.38)

Sinistrality. the predominant use of the left hand for unilateral skills (Oxendine, 1984, p.362)

Review of Related Literature

Oxendine (1984) submits that research relating to lateral dominance and bilateral transfer issues in any field has been slight. This is particularly true in the field of music. The present study is concerned with both handedness and bilateral transfer in relation to musical performance. This literature review, thus, will mainly focus on handedness and bilateral transfer issues in music, or such issues related to music through other fields. First, however, is a brief review of two experiments which support the mode of instruction for both of the present experiments.

Instructional Method

The music selections used in this study consisted of a melodic line for one hand and chordal figures for the other hand. Students were asked to prepare these pieces for performance using the basic premise behind Brown's (1928, 1933) combination and hands-together method. Although these techniques are commonly used for most piano instruction, a closer review of Brown's experimental support for these practice methods is warranted.

Brown (1928) wished to determine which method of practicing piano (whole, part, or combination) would be more effective in learning pieces of music. The whole method involved playing the music from beginning to end without stopping to correct errors. In the part method, the music was sectionalized and each section was equally practiced. In the combination method, the music was played sequentially (beginning to end), but measures where errors occurred were rehearsed. In this study, the music was chosen in groups of threes (one unit) that had similar attributes in measure numbers, time

signature, and degree of difficulty. Each piece (within each unit) was assigned one of the practice methods. A total of six units were analyzed by comparing the time and number of trials it took for the participants to perfect the music. Brown found that the whole and combination methods were the most efficient for the easiest music. She also found that the whole method was solely the most efficient when used on a piece of medium difficulty. The part method was found to be the least efficient in all categories.

In 1933, Brown looked at the relationship of two more methods of learning piano music. In this study, she used the hands-separate method and the hands-together method in an attempt to determine their efficiency for learning piano music. She defined the hands-separate method as practicing the treble clef and the bass clef separately, before performing the piece with both hands together. The hands-together method was defined as simply using the hands together.

Brown obtained results by comparing the differences between the two methods. Results were calculated by averaging the total performance time, degree of difficulty, total practice time, total number of trials (to ensure complete accuracy), and order of completion. Brown found that the hands-together method proved to be the more efficient method of practice in both speed and trials. She also found that the hands-separate method became increasingly inefficient as the trials progressed. In addition, she noted that participants expressed more pleasure in using the hands-together method. As a result of her research, the combination and hands-together methods seemed most suited for use in this study.

Handedness

In order to explore the relationship between left-hand piano training and performance, the issue of general handedness must be discussed. Handedness has been

shown to effect related subjects such as finger dexterity and hand-eye coordination. These skills are directly related to pianists' abilities to perform. Following is a review of several studies that are concerned with the handedness issue.

Kimura and Vanderwolf (1970) performed two identical experiments examining how the left and right hands compare on a simple motor task using individual finger movements. Each experiment used 48 individually tested participants.

First, each participant was asked to flex a designated finger at the middle joint without moving the bottom joint of the finger. In addition, the participants were asked not to move any other fingers. All eight fingers were tested. Next, participants were asked to move two fingers of one hand together, again flexing at the middle joint and not moving any bottom joints or other fingers.

In the first experiment, Kimura and Vanderwolf found that right-handers obtained significantly higher scores than left-handers. The left hand, however, was significantly superior to the right in both the single and the paired movements. Although the results in the second experiment were not identical to the first experiment, they again found that the left hand was significantly better than the right. They concluded that both left-handed and right-handed participants perform better with the left hand on a test of single and paired movement. In addition, the analysis of the data indicated that left-hand superiority occurred most consistently among right-handed subjects.

Parlow (1978) also studied the correlation of differential finger movements and hand preference. She attempted to replicate the results obtained by Kimura and Vanderwolf (1970), and duplicated their method used. Parlow found that both hands were equally proficient at both the single- and paired- movement tests. She also found a left-hand superiority for the right-handed participants.

Flowers (1975) investigated the handedness issue in regard to hand-eye coordination and tapping skills. He found that both right-handed and left-handed participants showed greater skill with their preferred hand on a visual aiming test. On a rhythmical tapping test, he found no significant differences in speed between right-handers or left-handers. He noted, however, that the left-hand group had the highest scores for both their preferred and nonpreferred hands.

Peters and Durning (1979) also compared left-handers and right-handers on a tapping task. They compared 90 right-handers and 90 left-handers (45 males and 45 females in each group). Each participant filled out a questionnaire to establish handedness, then was instructed on the proper tapping technique. Once proper tapping style was established, participants were instructed to begin tapping as quickly as possible. The task consisted of ten 10 second trials with the index finger of each hand, alternating from hand to hand. In addition, the beginning index finger was alternated from person to person.

Peters and Durning (1979) implied that the finger tapping task was a reliable means to differentiate between preferred hand and nonpreferred hand performance in left-handed and right-handed individuals. Participants were rated on speed and regularity of intertap interval. Results indicated that, overall, males tapped faster than females. However, females showed smaller differences in the regularity of tapping than did males. Left-handers demonstrated a smaller between-hand difference than did the right-handers. Finally, the results showed a significant difference in the speed and regularity of tapping performance. The preferred hand was almost always faster than the nonpreferred hand in tapping speed. However, almost twenty five percent of the participants demonstrated a significantly higher regularity of tapping with their nonpreferred hand.

Chapanis and Gropper (1968) explored the differences between hands on a simple dial setting task. They tested 64 college males for handedness and randomly assigned them to either the treatment or experimental group. Contrary to the previous studies, results indicated that right-handed students made slightly fewer errors with their preferred hands than the left-handed students made with their preferred hands. The left-handed students, however, made significantly fewer errors with their nonpreferred hands than the right-handed students made with their nonpreferred hands.

Kilshaw and Annette (1983) expanded handedness research by studying the effects of age, sex, and hand preference in a peg moving task. They examined hand preferences and hand skill in a total of 602 males and 843 females, ranging in age from approximately 3-50 years. In the hand-preference portion of the study, the results indicated that the distribution of hand preference showed little evidence of change with age.

Numerous conclusions were drawn from the results of the peg moving portion of the study. First, peg moving time generally decreased with age until the late teens, then remained steady until after 50 years of age, where an increase in time was observed.

✓ Males were faster with the left hand than females. Females tended to be faster in the right hand until around the age of 10, when males began to become faster with their right hands. In the peg moving task, as is consistent with Chapanis and Gropper, left-handers were faster in the nonpreferred hand than right-handers were in the nonpreferred hand. Left-handers and right-handers showed little differences in performance time with the preferred hand.

Handedness Issues In Music

This study is concerned with musical applications of the handedness issue.

Several experiments that address this particular application have been performed.

→ Evidence exists that each side of the brain controls (at least to some degree) the opposite side of the body (Annette, 1985; Coren, 1992; Fadely & Hosler, 1983; Herron, 1980). For example, the left hemisphere is associated with right-handedness, right-ear, right-footedness, and right visual dominance; while the right hemisphere is associated with left-handedness, left ear and footedness, and left visual dominance. Although either hemisphere can control either motor side, each motor side is normally controlled by the opposite hemisphere. The following reviews show evidence of increased left-handedness among musicians. Thus, it seems reasonable to assume that training right-handers to more efficiently use the right cerebral hemisphere/left hand may be beneficial to their overall musicianship.

↙ Oldfield (1969) felt that the cerebral arrangement regarding handedness may cause left-handed people to experience difficulty in instrumental performance. He also felt that this might result in a smaller proportion of left-handers among musicians than the population at large. Oldfield selected a handedness questionnaire to obtain the results for his study. He had 129 students and staff at two music schools complete the questionnaire which asked certain hand preference questions. He found that 20 percent of the respondents had tendencies toward sinistrality. He then asked 1128 psychology undergraduates to complete the same basic questionnaire, again finding about 20 percent sinistrality.

→ Oldfield also found that right-handed piano players must deliberately exercise their left hand to ensure adequate facility. Thus, he made the supposition that the role of the left hand is subordinate to the right hand in general piano playing. The left handers in

his survey noted that left-handedness created a handicap and that, by necessity, the right hand had acquired the greater skill. Oldfield also discovered that the sinistral subjects found difficulty in achieving use of the nonpreferred hand in conducting.

Similarly, Gotesam (1990) looked for the incidences of left-handedness among architecture and music students. He was also interested in incidences of mixed-handedness. He used a questionnaire to determine hand preference with a population total of 235 participants.

Gotesam reported that students of architecture and music had higher frequencies of strong left-handedness with a slightly lower frequency of left mixed-handedness than the general population. The architecture students showed a greater incidence of strong left-handedness, while the music students showed a greater incidence of left mixed-handedness. Strong right-handedness and right mixed-handedness were roughly similar when compared with the general population. Architecture students showed a higher incidence of right mixed-handedness than music students, while music students displayed a higher incidence of right-handedness than architecture students. Overall, women tended toward sinistrality while men tended to be dextral.

Byrne (1974) attempted to determine whether or not bilateral language representation occurs at the expense of certain musical and spatial abilities. First, Byrne assessed the handedness patterns of staff and students of the N.S.W. Conservatorium of Music, Australia, and compared them with a random sample of university students. Handedness was assessed using Oldfield's Edinburgh Handedness Inventory (as cited in Byrne, 1974). Next, he tested 41 right-handed and 30 mixed-handed participants on timbre perception and tonal memory by using the Seashore subtests. Finally, Byrne tested verbal intelligence by using the A.C.E.R. AL Test (a test designed to measure verbal IQ).

Byrne's population for the handedness survey consisted of 134 vocal students, 108

instrumental students, and 864 randomly selected students. He found no evidence of greater numbers of right-handers over mixed-handers among the musicians. Instead, he found an excess of mixed-handers among the instrumentalists. In addition, his second set of experiments (Seashore and Verbal IQ tests) showed interesting results.

The Seashore subtests (as cited in Byrne, 1974) showed minimal difference in timbre perception for right-handers and mixed-handers (scores were calculated at 40.8 and 40.1, respectively, with a maximum score of 50). Similarly, tonal memory showed minimal differences (scores were calculated at 18.7 and 17.9, respectively, with a maximum score of 30). A *t*-test was used to determine that no significant differences were evident for right-handers and mixed-handers. Finally, evidence showed that right-handers and mixed-handers scored similarly on the Verbal IQ test, with scores of 121.5 and 120.8 respectively. Thus, Byrne submitted a case for the independence of musical abilities and handedness.

An alternative interpretation surmised by Byrne was that bilateral language occurs at the expense of some right brain functions, such as spatial operations, but not at the expense of others, such as music. He gave a further alternative by implying that timbre perception, tonal memory, and language all function alike because they occur in the same areas of the brain.

The connection between handedness and musical ability was further studied by Aggleton, Kentridge, and Good (1994). They attempted to assess the hand preferences among three groups of professional musicians. Professional orchestral players, composers, and choir members were assessed using two tools, Oldfield's Edinburgh Handedness Inventory (as cited in Aggleton *et al.*, 1994), and writing hand preference. A total of 1,538 questionnaires were returned, with 623 completed by orchestra members, 331 by composers, and 584 by choir members. These participants were then categorized

as strong left-handers, strong right-handers, moderate left-handers, or moderate right-handers.

The control group for the handedness assessment was assembled using the data from a survey of 6,097 people conducted by Ellis, Ellis, and Marshall (1988). Each participant was matched with a single subject (according to sex and age) from the Ellis *et al.* (1988) study. Additional comparisons for the writing hand preferences were made using a mail survey of randomly selected adults from the electoral roll of four British cities (Davis & Annette, 1994).

Aggleton *et al.* found that 12.2 percent of the male musicians were left-handed, as compared to 11.8 percent of the female musicians. The corresponding control group percentages were 8.5 and 7.3, respectively. With such small differences, Aggleton *et al.* found that there were no systematic effects of sex on handedness among the musicians. In addition, there was no evidence to support a relationship between handedness and type of musician. However, an increase in the occurrence of left-handedness in musicians in relationship to the control group was found.

Phillips (1985) proposed to examine the incidences of handedness among music students and the role of handedness as it relates to teaching strategy. He divided his experiment into two phases: Phase I, which dealt with the handedness of public school and college students; and Phase II, which dealt with the teaching strategy of a bimanual musical performance skill.

In Phase I, a total of 1,164 participants were assessed for handedness using the Edinburgh Handedness Inventory (Oldfield, 1971). These participants were chosen from the fourth, seventh, and tenth grades, as well as a freshman class of college musicians from the Eastman School of Music.

Phillips found that there was a significant difference between the fourth grade nonmusicians and fourth grade musicians, with a higher incidence of right-handedness among the musicians. However, he found no significant difference between seventh and tenth grade nonmusicians and seventh and tenth grade musicians. In addition, he found no significant difference in handedness when he compared the samples of fourth through tenth graders and college freshman, although left-handers did show some tendency to continue on their chosen instrument as they progressed through school. Finally, Phillips found no significant relationship between the choice of instrument and hand preference.

Phase II of Phillips' experiment involved 16 seventh grade students, all with an average of three years of public school music instruction. Eight left-handed and eight right-handed participants were selected from the public school sample from Phase I of the experiment. Since they were instructed in a bimanual musical performance task on a marimba, pianists were excluded from Phase II, due to the familiarity they would exhibit toward the physical arrangement of the marimba.

A pretest-treatment-posttest design method was used during Phase II of the experiment. Participants were asked to prepare a set of musical exercises (modules) to the point of no detectable errors before moving to the next exercise. Eight students (four right-handed and four left-handed) were taught using a linear, or sequential, method. The remaining eight students (four right-handed and four left-handed) were taught using a Gestalt (imitative) strategy. All students were given individual thirty minute lessons. Phillips found that handedness was not a factor during musical performance. He also found no significant difference between the influence of teaching strategy and execution of a musical performance task.

Deutsch (1978) stated that neurological differences in cerebral dominance/handedness may be reflective of variances in different abilities; specifically,

the correlation between left-handedness and musical processing ability. She used 76 right-handed undergraduates and 53 left-handed undergraduates. A test tone was presented and followed by a sequence of six interpolated tones, with a second test tone at the end of the sequence. Twenty-four sequences were presented in two equal groups. A 10 second pause was given between sequences within a group and a two minute pause was given between the groups.

Deutsch found that the sinistral group displayed a significantly higher variance than the dextral group. Furthermore, the sinistral group made fewer errors than the dextral group. The left mixed-handedness group showed a significantly higher accuracy rate than the strong left-handers, right-handers, and right mixed-handers. In addition, there was no significant difference in the accuracy rate of the latter three groups.

The correlation between left-handedness and musical ability was further studied by Craig (1980). Craig tested for superior performance in the responses of left-handed individuals to a dichotic rhythm task. Participants included 25 right-handed and 11 left-handed undergraduate and graduate students. Each student received a series of four-beat auditory rhythm patterns of five tones. Each pattern was presented in random order to either the right or left ear. Students were asked to reproduce the rhythm pattern by tapping one of two keys on a response board with their preferred hands. They were asked tap the right key for each individual note heard in the right ear, and tap the left key for each individual note heard in the left ear. Three experimental conditions were present, with each condition containing eight dichotic pairs of patterns.

Craig determined that both the right-handed and left-handed participants detected an approximately equal number of signals from each of the three conditions. There was no significant difference in response levels of laterality and nature (signal or nonsignal). The left-handed students responded with an accuracy level of 92.6 percent, while the

right-handed students had an accuracy response of 93.6 percent. However, there was a significant difference in the correct number of signals reported. Left-handed students correctly reported an average of 75 percent of the 16 signals of each condition, while the right-handers correctly reported only 56 percent of the 16 signals. Craig concluded that the left-handed subjects were better able to analyze simultaneous stimuli and combine distinct information from them into an organized structure.

In a related study, Kimura (1964), questioned whether the right hemisphere of the brain was superior to the left hemisphere in relation to perception of musical sounds, by comparing efficiency level between verbal material and melodies. Kimura tested 20 right-handed females by presenting two auditory tasks. The first task consisted of a presentation of three pairs of digits so that different numbers arrived at both ears at the same time. Next, participants reported (in any order) all the numbers heard. Kimura found that the right ear was significantly superior to the left in perception of the verbal material.

The second task involved playing eighty short melodies (divided into 20 sets of four) by Antonini, Bach, Mozart, and Telemann. Two of the four melodies were presented at the same time, one in each ear. There was a short pause and then all four melodies were played in normal succession to both ears. The participant had to identify which two melodies were the original two. Kimura found that the left ear was significantly better in perception of melodic material. Thus, Kimura concluded that the right hemisphere appears dominant for musical perception, due to left ear superiority in melodic recognition.

Bilateral Transfer

Not only does the issue of general handedness affect this study, but the issue of bilateral transfer is also directly involved. Several studies have examined the effects of bilateral transfer on motor skill tasks such as dancing, tapping, writing, and typing. Similarly, this study examined the transfer of the melodic line in piano playing. A review of the related studies follows.

Puretz (1983) tested for the effects of bilateral transfer on two complex dance movement sequences. Forty right-handed undergraduates were recruited, and subsequently divided into two groups. The naive group consisted of participants with no dance training, while the experienced group consisted of participants who had between six months and four years of dance training. Within each group, participants were randomly assigned to one of four test conditions: preferred side to nonpreferred side and one-trial learning, preferred side to nonpreferred side and practiced learning, nonpreferred to preferred side and one-trial learning, and nonpreferred to preferred side and practiced learning. Participants performed two different dance movement patterns labeled 'lean' and 'backward walk'. Puretz videotaped the dancers, who were then judged by three evaluators using a semantic differential scale involving technical ability, movement integration, expressive state, and shape.

An ANOVA yielded significant effects for nonpreferred side to preferred side in the practiced task subsection in both the naive and experienced groups. Puretz suggested that complex dance movement sequences should be taught from the nonpreferred to preferred side.

In another study involving large movements, Greer (1976) studied the effects of bilateral transfer upon learning the volleyball spike. She was interested in determining when the nonpreferred hand should be introduced in learning to spike a volleyball. She

divided 41 volunteers into three groups. Group 1 practiced with alternate hands, beginning with the preferred hand. Group 2 practiced with the preferred hand only. Group 3 practiced for three weeks with the preferred hand, then switched to the nonpreferred for three weeks.

The results of the analysis indicated a significant difference in spiking ability from the initial sessions to the conclusion of the treatment, with each participant using either the preferred or nonpreferred hand. Bilateral transfer occurred between the preferred hand and nonpreferred hand in spiking scores, however, there was no significant difference between the spiking scores of the preferred hand and nonpreferred hand. Thus, Greer concluded that no inference can be made concerning when the introduction of the nonpreferred hand should occur in order to increase bilateral transfer.

Hicks (1974) studied the issue of bilateral transfer in smaller movements. He used four independent groups of forty right-handed participants to practice printing inverted and reversed letters using their left or right hands. The four groups were thus l-l, r-r, l-r, and r-l, with the first letter designated as the hand practiced with during the first phase of the experiment, and the second letter designated as the hand printed with thereafter. Participants were told to print the alphabet in uppercase, inverted and reversed. The experiment for all participants was divided into two sets of ten trials, with each trial lasting 30 seconds and an intertrial interval of 30 seconds. At the end of the first twenty trials, half the participants were dismissed, and five more trials took place.

Hicks found that the l-r group performed as well as the r-r group. In contrast, the r-l group did not perform at the level of the l-l group. Furthermore, the comparison revealed that previous left-handed practice benefited right-handed performance more than previous right-handed practice benefited left-handed performance. Hicks concluded that the processes controlling performance with the left hand in group l-r were similar to those

controlling performance with the right hand. However, the processes controlling performance with the right hand in group r-l were much less similar to those controlling performance with the left hand.

Freeman (1938) also studied the bilateral transfer effects in normal and mirror writing. He used three college women, one who was left-handed, one who was right-handed, and one who was ambidextrous. Participants were instructed to write the alphabet in one hand for one minute, switch to the other hand for ten minutes, then back to the original hand for one minute. Freeman introduced them to six experimental periods involving different initial hands and writing direction (forward or backward).

While Freeman admitted that the small sample size made his results insignificant, he noted that bilateral transfer was always greater from practice of a reverse movement rather than practice in the same direction. Also, he noted that the preferred hand gained more by reverse practice in the nonpreferred hand. Freeman concluded that the left-handed participant achieved greater transfer with reverse practice in the right, while the right-handed participant attained better scores with reverse practice in the left.

Hicks, Gualtieri, and Schroeder (1983) examined the extent of bilateral transfer of same and mirror-image movements on a rotary pursuit task. The experimental group consisted of 240 right-handed college students, who were subsequently divided into eight groups of 30. They used their left hands for the first phase of the experiment and their right hands for the second phase, and were assigned to perform the task either clockwise or counterclockwise. There were two control groups of 30, which performed the task (either clockwise or counterclockwise) with their right hand in both phases of the experiment.

In the first phase, the control groups were found to perform at a superior level to the combined experimental groups for the first 25 trials. In the second phase, the control

groups again out-performed the transfer groups, but improvement in the experimental groups' scores indicated some transfer took place between the two phases.

Dunham (1977) also used a rotary pursuit task in his examination of bilateral transfer. He investigated the effects of practice order on the efficiency of bilateral skill acquisition. Dunham used sixty right-handed undergraduate male volunteers. Participants were divided into one of four practice orders; preferred serial (rlrl...), preferred sequence (r...l...), nonpreferred serial (lrlr...), and nonpreferred sequence (l...r...). Participants had to reach a performance level of 70 percent accuracy on a simple motor skill. They were given six 20 second trials with intertrial rests of one minute. Dunham found no significant interaction between initial hand and overall performance. However, he did find sequential ordering to be the most advantageous.

Gleason (1977) used a rotary pursuit task and attempted to determine the differences in rate of learning and amount of bilateral transfer between the dominant and nondominant hand. She was also concerned with the effects of age on learning and bilateral transfer. Gleason used 96 school-aged children ranging from 7-17 years old. The tasks consisted of 14 trials, each 30 seconds in length, with 10 seconds between trials. The students performed seven trials with their dominant hands and seven with their nondominant hands.

While Gleason found no significant difference between the dominant and nondominant hand rate of learning, she found that bilateral transfer was greater from the dominant side to the nondominant side. Furthermore, she concluded that age had an effect on learning and bilateral transfer. Gleason indicated that children aged 11 experienced significantly more dominant gain than children aged 9, 13, and 17. Children aged 15 experienced significantly higher gains than children aged 9 and 17.

Turnbaugh (1976) measured performance on a rotary pursuit task and compared the amount of bilateral transfer in terms of handedness, practice, and sex. She also explored comparisons between the initial and final first-hand performances. Turnbaugh used 48 left-handed freshmen (18 male and 40 female), matched them with a right-handed partner of the same sex, and randomly assigned the pairs to groups. Half of the groups initially performed with the dominant hand, while the other half used the nondominant hand. A total of 36 trials were completed with periodic rest intervals. Each trial was 30 seconds in length.

The statistical analysis indicated that final performance and transfer scores favored the left-handed students. Handedness practice significantly indicated that left-handedness and dominant limb performances were superior. In addition, males scored significantly higher than females on initial and final performances. Turnbaugh concluded that the practice/sex variable had significant effects on the transfer scores such that left-handed performers and male performers displayed more transfer.

In their investigation of bilateral transfer, Taylor and Heilman (1980) performed two experiments concerned with left-hemisphere dominance in right-handers. They hypothesized that new skills would be gained more rapidly by the right hand than the left hand. A further hypothesis proposed that the right hand would have more direct access to skills learned by the left hand, thus bilateral transfer would be greater from the left hand to the right.

The first experiment involved 16 male and 16 female volunteer college students (all right-handed) who were asked to perform a sequence of key-pressing tasks on a modified typewriter keyboard. Each participant was given one trial of 30 seconds in duration, per hand, during the pretraining phase. Participants were then told whether to perform the task with their left hand or right hand, with half of the participants of each

sex using the right hand and the other half using the left. A screen was then placed in front of the keyboard, so that students could not see it.

In the training phase, each student was given 25 trials with the assigned hand only. If a mistake was made, a tone sounded, indicating to the participant to go back and correct the last sequence. In the post-training phase, each student was given one trial with each hand. The second experiment was similar to the first, except in the area of sensory feedback. The screen was moved so that students could see the keyboard.

An analysis of the pretraining indicated that there was little initial advantage for either hand, although the left showed an insignificantly higher mean performance score. The results of the first experiment indicated that males showed faster acquisition with right-hand training than left-hand training, but showed greater transfer from left hand to right hand. Females showed neither asymmetry. In the second experiment, both sexes showed greater right-hand skill acquisition, and, yet again, a greater transfer effect from the left hand to the right hand. Taylor and Heilman concluded that there was evidence to support a concept for left-hemisphere motor dominance in both males and females.

Frank (1975) also used a sequential typing task to explore motor asymmetry in bilateral transfer. Participants (all right-handed) were divided into 32 groups of four and assigned to one of four experimental typing conditions. All participants received both written and verbal instructions before the practice, or first, phase of the experiment. Frank gave ten trials during both the practice and test phases, and five trials during the interference phase.

Frank found that a significant amount of bilateral transfer took place in the right hand when practice took place with the left hand. Similarly, he found that transfer occurred in the left hand when practice took place with the right hand. Frank concluded

that the transfer from the right hand to the left hand was equal to transfer from the left hand to the right hand.

Ulich (1963) conducted two experimental series using a finger dexterity test. In each experiment, the relative amount of bilateral transfer was evaluated. Experiment 1 included 169 students from ages 11 to 14 years old. These students were divided into homogenous groups of 9 or 10, on the basis of a pretest. Each group received five minute trials. All groups showed positive transfer from the left to right hand and from the right to left hand. Significant differences did not appear in the relative amount of transfer between the left and right hand. In addition, there were no significant differences reported between male and female students, or older and younger students. Finally, the relative amount of transfer increased significantly after four interpolated trials, as compared to two interpolated trials.

Experiment 2 included 106 students, all aged 13 years old. The students were divided into 7 homogenous groups of 9 students each, again on the basis of a pretest. Groups in this experiment were given the opportunity to observe the practice of other students. These students were also given 5 minute trials. Results found that transfer from one hand to the other occurred after one student observed the practice of another. The amount of transfer was not dependent on which hand the student observed, and actually approximated the amount of transfer that occurred after the students actually practiced.

After comparing the results of the studies, Ulich (1963) concluded that students formed a "motion pattern" by observing the practice of other students. This pattern was found to influence the students' actual performance of the motion.

Similarly, Laszlo, Baguley, and Bairstow (1970) performed an experiment on bilateral transfer of a tapping skill. In pretest trials, under normal sensory feedback conditions, the preferred hand showed significantly higher performance levels than the

nonpreferred hand. Under negative feedback conditions, the pretest trials showed that performance did not differ significantly. The posttest analysis for positive sensory feedback showed that transfer occurred only for the nonpreferred hand, with the opposite occurring during negative sensory feedback conditions. Laszlo *et al.* did not specify, however, the hand preference of their subjects.

In a second experiment, Laszlo and Baguley (1971), specifying only right-handed participants, again studied bilateral transfer in a fast tapping task in normal and reduced feedback conditions. In pretest trials with normal feedback conditions, the preferred hand showed significantly higher performance levels than did the nonpreferred hand. In posttest trials under normal feedback conditions, positive transfer was found for the left hand only. In the reduced feedback situation, positive transfer occurred for the preferred hand only.

Summary

Research involving piano teaching strategy revealed that the whole method and the combination method were the most effective means of learning beginner level piano music. Further research suggested that beginning pianists should practice the piano using both hands at the same time. Thus, the association of the whole method, combination method, and hands-together method would appear to be the most efficient approach to beginning piano study.

Research involving handedness and motor tasks has produced varied results. There is evidence that both left-handers and right-handers perform better with the left hand on motor tasks. Conversely, evidence exists that maintains superior preferred hand performances over nonpreferred hand performances in both left-handers and right-

handlers. There is also evidence to suggest no difference between the performance levels of left-handers or right-handers in certain motor tasks.

Studies regarding handedness and musicianship have produced differing results. While evidence exists showing marked incidences of left-handedness amongst musicians when compared with the general population, there are contrary indications that exhibit little or no difference in the incidences of left-handedness amongst musicians. There is general agreement that left-handers are better at dichotic listening tasks, and that the right hemisphere of the brain (whether left-handed or right-handed) is more efficient than the left hemisphere in regard to musical listening tasks.

Bilateral transfer research has also produced varied results. Some research concludes that more transfer occurs from the preferred or dominant side to the nonpreferred or nondominant side. Other studies have shown a significant increase in transfer from the nonpreferred or nondominant side to the preferred or dominant side. Evidence also exists that shows a greater amount of transfer occurring among left-handers.

It would appear from the review of literature that information relating to handedness and bilateral transfer are inconclusive, suggesting a need for further research into these areas.

Experiment I

Method

Participants

Volunteers for this pilot study were taken from students in instrumental and choral ensembles of a large Mid-Atlantic university. The participants were selected based upon knowledge of music fundamentals. The music fundamentals included note recognition on at least one clef (treble or bass), a basic working knowledge of notation, note values, key signatures, and time signatures. An additional requirement for the participants was a lack of any training, either formal or informal, in piano. Out of the group of ten volunteers, six were randomly selected for this study.

Materials

Alfred's Basic Adult Piano Course - Level One (Palmer, Mamus, & Lethco, 1983), an adult piano beginning method book, and music written with Mosaic (1993) were used as the basic instructional tools for the study. *Piano Repertoire*, from the David Carr Glover Piano Library (Glover & Garrow, 1968) was used during the posttest. The participants were furnished a new copy of the book, along with a two week practice log. The Yamaha Clavinova, an electronic piano, was the instrument used for all instruction and the posttest. In addition, a Mitsubishi CX 7 S-VHS video camera was used to videotape the participants during the posttest. The videotaped performance of each participant was viewed on a television monitor. Finally, a packet containing a copy of the posttest music (Appendix A) and five study assessment sheets (Appendix B) was given to each evaluator in the study.

Procedure

The group of six participants was randomly assigned to either the control group or the treatment group, with three participants in the control group and three in the treatment group. As a result of random assignment, there were two right-handed participants and one left-handed participant per group. The control group was instructed by using simple melodies in the right hand and chordal figures in the left hand. The control group, thus, was taught to play the piano using the "traditional" or "normal" method of piano instruction. Conversely, the treatment group was instructed by using simple melodies in the left hand and chordal figures in the right hand.

Instruction. Each group had thirty minutes of instruction twice weekly for two weeks. The instruction concentrated on having the participants play the correct notes and learn a moderate degree of technical proficiency (correct hand position and finger fluency). Both groups were given assignments to practice for the subsequent lessons. They were instructed to practice using Brown's (1928,1933) combination and hands-together methods while practicing. The music for the assignments (Appendix A) was taken from *Alfred's Basic Adult Piano Course - Level One* (Palmer *et al.*, 1983). Each participant was responsible for keeping a daily log of how much he/she practiced for the duration of the study. The practice logs were checked on a weekly basis and collected at the end of the study.

Posttest. At the last group lesson, each individual was given a time to perform the posttest. For the posttest, each individual was asked to perform an excerpt from "Cardboard Soldiers" (Appendix B) from the primer level of *Piano Repertoire*, from the David Carr Glover Piano Library (Glover & Garrow,1968). Each participant was then given 2.5 minutes to prepare the music following Brown's (1928,1933) combination and hands-together methods while practicing. Next, they were allowed to look at the music

and practice on the piano if desired. A tempo of 72 beats per minute was given with a metronome and the student was asked to begin practice. At the end of the 2.5 minute period, the student was instructed to end practice. The video camera was turned on, the tempo was again given, and the student was asked to play the music selection. The participant was then thanked and excused.

Evaluation. The posttest recordings were then evaluated by a panel of four graduate music students and one music professor. The assessment utilized a semantic differential scale. Each evaluator was given a packet containing a copy of the posttest music (Appendix B) and five study assessment sheets (Appendix C). The panel then listened to a correctly played audio taped performance of the music. Next, the videotaped performance of each participant was viewed on a television monitor. At the end of each participant's performance, the panel was instructed to assess the performance. Finally, the data were collected and analyzed.

Results

Five participants completed the performance assessment stage of this study. Each participant was evaluated in the following five categories (Appendix B): Pitch Accuracy in the Left Hand (PALH), Pitch Accuracy in the Right Hand (PARH), Rhythmic Accuracy in the Left Hand (RALH), Rhythmic Accuracy in the Right Hand (RARH), and Overall Technical Proficiency (OTP). The summated scores in each category were analyzed.

A two-tailed independent *t* -test was used to analyze the differences between the control and experimental participants' performances. Table 1 presents a summary of the analysis of the control and treatment group means and the standard deviation in each category. The treatment group means were higher in each category. The critical regions for rejection on all statistical analyses were set at the .05 and .02 levels of significance

($p < .05$ and $p < .02$). The critical limit for rejection with three degrees of freedom ($df = 3$) at $p < .05$ is 3.182. The critical limit for rejection at $p < .02$ is 4.541. As shown, all results were significant except PARH and RARH.

Experiment II

Method

Participants

Volunteers for this expanded study were taken from the marching band of a large Mid-Atlantic university. All marching band members were asked to volunteer for a piano study, and were only told that they would receive 10 free piano lessons over an eight week period. Participants were chosen from the marching band in order to ensure a knowledge of music fundamentals. The music fundamentals included note recognition on at least one clef (treble or bass), a basic working knowledge of notation, note values, key signatures, and time signatures. An additional requirement for the participants was a lack of any training, either formal or informal, in piano. The final prerequisite was that all participants must be right-hand dominant, based on the hand used in writing. Out of a group of 32 volunteers, 24 were randomly selected for this study.

Materials

Alfred's Basic Adult Piano Course - Level One (Palmer, Mamus, & Lethco, 1983), an adult piano beginning method book, and music written with Mosaic (1993) were used as the basic instructional tools for the study. *Piano Repertoire*, from the David Carr Glover Piano Library (Glover & Garrow, 1968) was used during the posttest. The participants in the control group were furnished a copy of the book, along with a two month practice log. Participants in the treatment group were given music written with Mosaic (1993), along with a two month practice log. The same Yamaha Clavinova, a full-sized electronic piano, was used for all instruction and the posttest. In addition, a Mitsubishi CX 7 S-VHS video camera was used to videotape the participants during the posttest. The videotaped performance of each participant was viewed on a Mitsubishi

XC3715C television monitor using a Sony SLV-S8514 F VCR. Audio was produced by a Roland M-480 mixer using a JBL SR6630 Audio Amplifier with two JBL 4412 control monitors. Finally, a packet containing a copy of the posttest music (Appendix C) and 20 study assessment sheets (Appendix D) were given to each evaluator in the study.

Procedure

The group of 24 participants was randomly assigned to either the control group or the treatment group, with 12 participants in the control group and 12 participants in the treatment group. The control group was instructed by using simple melodies in the right hand and chordal figures in the left hand. The control group was thus taught to play the piano using the "traditional" or "normal" method of piano instruction. Conversely, the treatment group was instructed by using simple melodies in the left hand and chordal figures in the right hand.

Instruction. Each group had thirty minutes of instruction for ten lessons over a seven week period. The instructional goal concentrated on having the participants perform with a moderate degree of cumulative technical proficiency as listed below:

Week 1: Note recognition on the clef (treble or bass) that was the least familiar to the individual participant was emphasized.

Week 2: Correct hand position was emphasized in regards to the physical relationship to the keyboard. (Participants were to be aware of elbow distance from the keyboard, as well as to have their fingers slightly curved and wrists slightly lowered, while performing their assigned music.)

Week 3: Correct notes and correct fingering were stressed.

Week 4: Finger fluency (defined in this study as smooth, or legato, playing between notes, chords, and phrases) was the emphasis for this week's instruction.

Week 5: Instruction for this week involved a review of the previous four weeks' instruction, with a required performance of each participant successfully demonstrating the aforementioned techniques.

Week 6: Proper pedaling technique was introduced. (This technique was introduced last as it is usually the most difficult for beginning students to conceptually grasp and physically execute properly.)

Weeks 7 and 8: Instruction for these weeks involved successful completion of the final assignments demonstrating all of the aforementioned techniques.

Throughout the study, students were instructed to practice using Brown's (1928,1933) combination and hands-together methods while practicing. The music for the assignments (Appendix A) were taken sequentially from *Alfred's Basic Adult Piano Course - Level One* (Palmer *et al.*, 1983). Control group assignments came directly from, and performed from, the book. Control group participants were specifically instructed to practice only marked assignments. Treatment group assignments were arranged directly from the book, written with Mosaic (1993), photocopied, and given to each participant. Exact melodies were placed in the left hand and exact chordal figures were placed in the right hand. Practice logs were distributed to each participant, who was responsible for keeping a daily practice accounting of how much he or she practiced. The practice logs were checked on a weekly basis and collected at the end of the study.

Posttest. At the last group session for the control group and for the treatment group, each individual was asked to choose a time to perform the posttest (the posttest was dated exactly one week after the last group lessons). The posttest was performed individually. No participants other than the performer were allowed in the posttest room during the preparation or performance time. For the posttest, each individual was asked to perform an arrangement of "Cardboard Soldiers" (Appendix D) originally taken from the

primer level of *Piano Repertoire*, a part of the David Carr Glover Piano Library (Glover & Garrow, 1968). The arrangement was written using Mosaic (1993), so that each arrangement had an equal number of melody notes and chordal figures. The participants had not seen this piece before entering the posttest room. Each participant was given 2.5 minutes to prepare the music following Brown's (1928,1933) combination and hands-together methods while practicing. They were allowed to look at the music and practice on the Yamaha Clavinova. A tempo of 72 beats per minute was set using a metronome (eight clicks). At the end of the 2.5 minute period, the student was again given eight clicks of the metronome set at 72 beats per minute, then asked to begin performance of the piece (Appendix E). Each participant was video taped using a Mitsubishi CX 7 S-VHS video camera. After the participant had completed the task, he or she was thanked and excused.

Evaluation. The posttest recordings were evaluated by a panel of three graduate music students and one music professor. The assessment utilized a semantic differential scale. Each evaluator was given a packet containing a copy of the posttest music (Appendix D) and 20 study assessment sheets (Appendix F). The panel then listened and observed a correctly played performance of the music. Next, the videotaped performance of each participant was viewed on a Mitsubishi XC3715C television monitor using a Sony SLV-S8514 F VCR. Audio was produced by a Roland M-480 mixer using a JBL SR6630 Audio Amplifier with two JBL 4412 control monitors. At the end of each participant's performance, the panel assessed the performance. Finally, the data were collected and analyzed.

Results

Twenty participants completed the performance assessment stage of this study, with 10 participants in the experimental group and 10 in the control group. Each

participant was evaluated by 4 judges on the following criteria (Appendix D): Pitch Accuracy in the Left Hand (PALH), Pitch Accuracy in the Right Hand (PARH), Rhythmic Accuracy in the Left Hand (RALH), Rhythmic Accuracy in the Right Hand (RARH), and Overall Technical Proficiency (OTP). The summated scores for each category were analyzed.

A two-tailed independent *t*-test was used to analyze the differences between the control and experimental participants' performances. Table 2 presents a summary of the analysis of the control and treatment group means and the standard deviation in each category. The treatment group means were higher in each category. The critical regions for rejection on all statistical analyses were set at the .05 and .02 levels of significance ($p < .05$ and $p < .02$). The critical limit for rejection with three degrees of freedom ($df = 18$) at $p < .05$ is 2.101. The critical limit for rejection at $p < .02$ is 2.552. As shown, significant results were obtained for all categories except PARH.

Interrater reliability for the assessment sheet results was calculated using a coefficient alpha. Interrater reliability was computed to be 92 percent. The average individual practice time per week for the control group was 50.1 minutes, while the average individual practice time for the treatment group was 52.6 minutes per week.

Discussion

This study attempted to answer the following question: What is the effect of left-hand training on piano performance? In both Experiment I and Experiment II, the significance of the results in the PALH and RALH categories indicated that the early left-hand training increased the participants' abilities to perform accurately with the left hand. It seems clear from the scores that the treatment group fared better in left-hand performance than their traditionally trained counterparts.

Interestingly, the analysis of the categories describing right-hand performance, Pitch Accuracy in the Right Hand and Rhythmic Accuracy in the Right Hand, produced varied results. In the Pitch Accuracy in the Right Hand category a slight, though insignificant, improvement was indicated for the treatment group over the control group in both studies. The Rhythmic Accuracy in the Right Hand category showed no significant improvement in Experiment I, yet showed a significant improvement in Experiment II. In both experiments, the values for Rhythmic Accuracy in the Right Hand were higher than the values for Pitch Accuracy in the Right Hand. These results indicated that the left-hand training of the treatment group had positive effect on the skill with which the participants played with their right hands.

Additionally, the Overall Technical Proficiency category showed significant results in both experiments. These results indicated that the left-hand treatment group had an advantage in overall performance over the right-hand control group. Thus, the performance as a whole was better for those participants who had been trained in the left hand.

According to the results of this study, it can be asserted that left-hand training has a positive effect on piano performance. These results are supported by studies that suggest a nonpreferred hand superiority in finger movement tests among right-handers (Kimura & Vanderwolf, 1970; Parlow, 1978). Certain aspects of piano playing involve finger movements that are similar to those movements in the aforementioned studies.

Also supportive of the results are certain studies in bilateral transfer. Bilateral transfer has been shown to occur from the nonpreferred hand to the preferred hand (Freeman, 1938; Laszlo *et al.*, 1970; Poretz, 1993; Taylor & Heilman, 1980). The former studies are indicative of the results obtained in this study. Bilateral transfer did occur from the nonpreferred hand to the preferred hand in the Pitch Accuracy in the Right Hand and Rhythmic Accuracy in the Right Hand categories. Although the results did not always show significance, some amount of transfer did occur.

Equally important to the current study are related studies between handedness and musicians. Studies by Aggleton *et al.* (1994), Gotesam (1990), and Oldfield (1970) support the theory of a higher incidence of left-handedness or mixed-handedness among musicians. Craig (1980) found that left-handers displayed an advantage in a dichotic rhythm test. Deutsch (1978) found that left-handers and mixed-handers made significantly fewer errors than right-handers on a pitch memory task. Kimura (1964) performed a dichotic melodic recognition test and found the left ear (thus right hemisphere) to be superior in the perception of melodic material. Thus, there seems to be some advantage for the left hand in music. However, the current study used only right handers, and significant results were nonetheless observed for the left hand. Since evidence exists that each side of the brain controls the opposite side of the body (Annette, 1985; Coren, 1992; Deutsch, 1978; Fadely & Hosler, 1983; Herron, 1980; Kimura, 1964),

it seems reasonable to assume that training right-handers to more efficiently use the right cerebral hemisphere, thus their left hand, may be beneficial to their overall musicianship.

Limitations of this study include small sample size, study time constraints, and limited resources. This study should be expanded for further accuracy and information. Possible future research should include studies with larger numbers of participants, and studies with different age groups, backgrounds, and preferred hands.

APPENDICES

Appendix A

Control Group Assignment Example (excerpt)

LONDON BRIDGE

Appendix B

Experiment I Posttest

CARDBOARD SOLDIERS

The musical score for 'CARDBOARD SOLDIERS' is presented in two systems, each with a treble and bass staff. The key signature has one flat (B-flat) and the time signature is 4/4. Fingerings are indicated by numbers 1-5 above or below notes. The first system consists of four measures. In the first measure, the treble staff has notes G4 (finger 3) and A4 (finger 5), while the bass staff has a whole rest. The second measure has a whole rest in the treble and a half note D3 (finger 4) in the bass. The third measure features a half note G4 (finger 2) and a half note F4 (finger 2) in the treble, with a half note D3 (finger 4) and a half note C3 (finger 2) in the bass. The fourth measure has a whole rest in the treble and a half note D3 (finger 1) in the bass. The second system also consists of four measures. The first measure has notes G4 (finger 3) and A4 (finger 5) in the treble and a whole rest in the bass. The second measure has a whole rest in the treble and a half note D3 (finger 4) in the bass. The third measure has a half note G4 (finger 5) and a half note F4 (finger 3) in the treble, with a whole rest in the bass. The fourth measure has a whole rest in the treble and a half note D3 (finger 2) and a half note C3 (finger 1) in the bass.

Appendix C

Experiment I Study Assessment Sheet

PLEASE RATE EACH INDIVIDUAL PARTICIPANT TO THE DEGREE WHICH HE/SHE DEMONSTRATES THE FOLLOWING:

A. Pitch Accuracy in Left Hand

disagree 1 2 3 4 5 agree

B. Pitch Accuracy in Right Hand

disagree 1 2 3 4 5 agree

C. Rhythmic Accuracy in Left Hand

disagree 1 2 3 4 5 agree

D. Rhythmic Accuracy in Right Hand

disagree 1 2 3 4 5 agree

E. Overall Technical Proficiency

disagree 1 2 3 4 5 agree

Appendix D

Experiment II Posttest

CARDBOARD SOLDIERS



Appendix E

Experiment II Instruction Script

- You will have 2.5 minutes to practice this piece from the moment I shut the door. Your suggested tempo is 72. (Give 8 clicks on the metronome set at 72)

(Leave the room and shut the door, wait 2.5 minutes then re-enter)

- OK, here is your suggested tempo again. (Give 8 clicks again on the metronome set at 72) You may begin.

Appendix F
Experiment II Study Assessment Sheet

PLEASE RATE EACH INDIVIDUAL PARTICIPANT TO THE DEGREE WHICH HE/SHE DEMONSTRATES THE FOLLOWING:

A. Pitch Accuracy in Left Hand

poor 1 2 3 4 5 excellent

B. Pitch Accuracy in Right Hand

poor 1 2 3 4 5 excellent

C. Rhythmic Accuracy in Left Hand

poor 1 2 3 4 5 excellent

D. Rhythmic Accuracy in Right Hand

poor 1 2 3 4 5 excellent

E. Overall Technical Proficiency

poor 1 2 3 4 5 excellent

Table 1

Experiment I Results

| | A | B | C | D | E |
|----------------------|--------|--------|--------|--------|--------|
| Control Group Mean | 7.500 | 11.500 | 9.500 | 12.000 | 8.500 |
| Treatment Group Mean | 17.333 | 17.667 | 17.667 | 17.333 | 18.000 |
| Standard Deviation | 5.727 | 4.438 | 4.669 | 3.633 | 5.675 |
| <i>t</i> - value | 4.790 | 2.032 | 5.792 | 2.342 | 3.982 |
| p - value | .02 | n.s. | .02 | n.s. | .05 |

Key:

n.s. -- The values were not significant.

A. Pitch Accuracy in Left Hand

B. Pitch Accuracy in Right Hand

C. Rhythmic Accuracy in Left Hand

D. Rhythmic Accuracy in Right Hand

E. Overall Technical Proficiency

Table 2

Experiment II Results

| | A | B | C | D | E |
|-------------------------|--------|--------|--------|--------|-------|
| Control Group Mean | 8.100 | 10.300 | 8.700 | 8.900 | 8.100 |
| Treatment Group Mean | 13.800 | 13.500 | 13.400 | 13.200 | 12.7 |
| Standard Deviation | 4.936 | 5.336 | 3.819 | 3.819 | 3.613 |
| <i>t</i> - value | 2.583 | 1.341 | 2.752 | 2.518 | 2.847 |
| p -value | .02 | n.s. | .02 | .05 | .01 |

Key:

n.s. -- The values were not significant.

A. Pitch Accuracy in Left Hand

B. Pitch Accuracy in Right Hand

C. Rhythmic Accuracy in Left Hand

D. Rhythmic Accuracy in Right Hand

E. Overall Technical Proficiency

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VITA

Carl Prescott (Scott) Humphries was born in Clifton Forge, Virginia in 1966 and is the son of Mack and Loretta Humphries of Covington, Virginia. Scott graduated from Alleghany High School in Covington in 1985, and received a Bachelor of Music Education from James Madison University in Harrisonburg, Virginia in 1989. Scott currently resides in Covington with his wife Paige, and daughters Christen and Brooke. He was the band director for Eastern Elementary, Macy McLaugherty Elementary, King Johnston Elementary, and Giles High School for Giles County Public Schools from 1989 - 1994. Scott remains active as a performing pianist and adjudicator, as well as a private instructor of piano and saxophone. Scott received a Master of Arts from Virginia Tech in 1996.

A handwritten signature in black ink, appearing to read 'Carl P. H.', with a stylized flourish at the end.