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The effects of musical training on academic achievement

John Schiavo
Rowan University

THE EFFECTS OF MUSICAL TRAINING

ON ACADEMIC ACHIEVEMENT

by
John Schiavo

A Thesis

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Approved by

Professor

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For my parents and in loving memory of Delores

Abstract

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Dr. John Klanderman and Dr. Roberta Dihoff
School Psychology Program

This study was designed to look at the cognitive development of students who have formal musical training and compare them to students who lack any musical ability. The purpose of the study was to lend support to the positive effect that musical training has on space relations and mathematical abilities.

The sample consisted of twenty students enrolled in an undergraduate psychology course at a major university and twenty students enrolled in a high level music class at the same institution. Most of the subjects came from middle class backgrounds and live in New Jersey. The Differential Aptitude Test, form C, was administered under standard conditions to measure the spatial relations and mathematical abilities of the forty subjects.

Independent t-tests were calculated to discover if there was a significance between the mean scores for both groups on both sections of the test. In addition, a paired samples t-test was calculated to see if there was a significance between the spatial relations and mathematical ability means for the same group.

The mean scores on both sections of the test were higher for the musically trained than those for the non-musical group. However, significance of the differences was only found for the spatial relations scores and not the math scores. Also, a significance was found for the hypothesis that suggests a relationship between space relations and mathematical ability.

Mini-Abstract

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Chapter One-The Problem

Need

The value of music education is being questioned like never before. There are more demands than money which forces administrators to make choices. It forces them to place value on each subject area. There is a great demand for concentration on the basics; English, math, science, and history. There is also a new focus on computer competency and the need for foreign language. In addition, health, family living, industrial arts, AIDS education, gym, and business education courses seem to push music education by the wayside. Plato was quoted to have said "Education in music is most sovereign because more than anything rhythm and harmony find their way to the innermost self and take a strong hold upon it, bringing them the imparting grade if one is rightly trained" (Republic). Music education has eroded dramatically since Plato's position. The idea of music education is good and it should be included in basic education. "The Imperative for Educational Reform" by the National Commission on Excellence in Education recommends that high schools provide vigorous programs in the fine and performing arts. The college board reports "academic preparation for college includes the arts as one of the six basics to be included in the school curriculum. Music education plays an important role in the education of our youth. This study attempts to seek out and examine some of the harmful effects that diminishing or eliminating music programs could have for our students and their futures.

Purpose

Through the use of the Differential Aptitude Test (spacial relations and mathematical aptitude sections) this study is designed to look at the cognitive development of students who have formal musical training of some kind and compare them to students who lack any musical ability. The purpose of this study is to lend support to the positive effect that music training has on space relations and mathematical ability.

Hypothesis

Students who have a specific musical ability will have higher scores on a space relations and mathematical aptitude test than students who have no formal musical training.

Theory

Howard Gardner states in "Frames of Mind" that there are seven forms of intelligence; linguistic, mathematical-logical, spatial, musical, bodily-kinesthetic, interpersonal, and intrapersonal. For the purpose of this research, musical, spatial, and mathematical-logical aspects of intelligence will be discussed.

Musical Intelligence

During infancy, normal children sing as well as babble. They emit individual sounds, produce undulating patterns, and can even imitate prosodic patterns and tones sung by others with better than random accuracy. It has recently been claimed that infants as young as two months are able to match the pitch, loudness, and melodic contour of their mother's songs. Also, infants at four months of age can match rhythmic structure as well. Mechtild Papousek and Hanus Papousek claim that infants are especially predisposed to pick up these aspects of music far more than they are sensitive to the core properties of speech and they can also engage in sound play that exhibits creative or generative properties (Gardner '93).

In the middle of their second year, children begin to emit their own series of tones that explore various small intervals; seconds, minor thirds, major thirds, and fourths. They invent spontaneous songs that are difficult to notate and shortly after, they begin to produce character sections of familiar songs that they hear around them. For instance, EI-EI-O from old MacDonald and "All fall down" from Ring Around the Rosie. By the age of three of four the production of songs and exploratory sounds generally wanes and the dominant culture melodies replace them.

There are striking individual differences in young children as they learn to sing. Some can match large segments of a song by age two. Others can only emit gross approximations of pitch and may still have difficulty in producing accurate melodic contours by age five or six. However, by the time children reach school age, most children in our culture have a schema of what a song should by like and can produce a reasonably accurate facsimile of the tunes commonly heard around them (Gardner '93).

There is little musical development after the school years begin. However, there is some increase in knowledge about music, as many individuals become able to read music, to comment upon performances, and to employ musical-critical categories such as sonata form and duplemeter. But as in the case with language, there is more emphasis in school on further linguistic attainments. Music is of little importance in our society and so musical illiteracy is acceptable.

The various lines of evidence suggest that like language, music is a separate intellectual competence which is not dependent upon physical objects of the world. Similar to language, musical facility can be elaborated to a considerable degree simply through exploration and exploitation of the oral-aural channel. Language and musical intelligence are two intellectual competencies that, from the earliest stages of development, can proceed without relation to physical objects. Although both rely on the oral-auditory system however, they do so in neurologically distinct ways.

Spatial Intelligence

Jean Piaget conducted several studies of the development of spatial understanding in children. Piaget saw spatial intelligence as part of the logical growth which he assembled across his diverse studies. Piaget spoke of sensory-motor understanding of space which emerges in infancy. In his theory, two abilities are central, the initial trajectories observed in objects and eventual capacity to find one's way between various locals (Cole '93). Piaget theorized that at the end of the sensory-motor stage of early childhood, they become capable of mental imagery. They can imagine a scene or event without having to be there. Mental imagery was seen as a kind of internalized action or deferred imitation.

Piaget introduced the distinction between figurative knowledge in which an individual retains the configuration of an object as in a mental image and operative knowledge, where the emphasis falls upon transforming the configuration as in the manipulation of such an image (Cole '93). The advent of concrete operations at the start of school marks an important turning point in the child's development. The child is now capable of far more active manipulation of images and objects in the spatial realm. The child can now appreciate how objects look to someone situated elsewhere. This is demonstrative of a well-known phenomenon called decentration where the child can indicate what a scene would look like to someone seated in another part of the room, or how an object would look if it were rotated in space. This variety of spatial intelligence is still restricted to concrete situations and events. Only during the formal operations era, at the time of adolescence, can the youth deal with the idea of abstract spaces or with formal rules of governing space (Cole '93). Thus, geometry comes to be appreciated by the adolescent, who is newly able to relate to the world of figural images to propositional statements and to the reason about the implications of various kinds of transformation.

There is a regular progression in the spatial realm from the infants' ability to move around in space, to the toddler's to form static mental images, to school child's capacity to manipulate such static images and finally, to the adolescent's capacity to relate spacial relations to proposition accounts. The adolescent being able to appreciate all possible spatial arrangements, is in a favorable position to join together logical-mathematical and spatial forms of intelligence into a single geometric or scientific system.

Mathematical-Logical Intelligence

This form of intelligence can be trace to a confrontation with the world of objects. Confronting objects, ordering, and reordering them, and assessing their quantity, young children gain the initial and most fundamental knowledge about the mathematical-logical realm. This form of intelligence becomes remote from the world of material objects. The individual becomes more able to appreciate the actions that one can perform upon objects, the relations one obtains from these actions, the statements that one can one can make about actual or potential actions, and the relationships among those statements (Gardner '93). Over the course of development, one proceeds from objects to statements, from actions to the relations among actions, from the realm of the sensory-motor to the realm of pure abstraction, and ultimately to the heights of logic and science. The roots of the highest regions of logical, mathematical, and scientific thought can be found in the simple actions upon physical objects in their world.

Assumptions, Limitations, and definitions

There are four central assumptions in this study. The first is that the study is assuming that the sample population is represenative of the entire population. Second, with regards to the testing conditions, it is assumed that the subjects will integrally complete the test battery to the best of their ability. Next, it is assumed that all of the members of the musically trained sample are functioning at the same level. Finally, and most important, it must be recognized that spatial relations ability may not be correlated with mathimatical ability. In addition to the four assumptions, there is one central limitation which is that the sample was drawn from a small college population.

Musical acuity refers to the ability to effectively read music and translate it to a musical instrument. Central to spatial intellingence are the capacities to perceive the visual world accurately, to perform transformations and modifications upon one's initial perceptions, and to re-create aspects of one's visual experience, even in the absence of relevant physical stimuli. Mathematical intelligence pertains to a confrontation of the world of objects, ordering and reordering them, and asssessing their quantity.

Overview

In chapter two, a review of the literature will be presented including an in depth look at the strengths and weaknesses of studies similar to this one in addition to how their findings may be incorporated or improved upon in this research. In chapter three, the design of the study will be the main focus. The nature of the sample, including the age, sex, and geographical location will be discussed. Also, the reliability estimates for the sample will be presented as well as the plan that will be followed at arriving at the probability statements about the nature of the variables. Finally, the hypothesis will be restated in testable form. In chapter four, an analysis of the data will be presented in tables and the acceptance or rejection of the hypothesis will be stated. Finally, a summary and conclusion of the results will be presented in chapter five.

Chapter Two-Review of the Literature

In this chapter, the relevant research pertaining to music training and academic achievement will be reviewed. This section will begin with an in depth look at two research studies that are closely related to this study and then overview the findings of other research done in the following areas; arts education and academic achievement, music education and academic achievement, music and pre-learning, music in reading instruction, music and math achievement, and a comparison study relating to the music educational practices of Japan and the United States.

Music Improves Reasoning in Preschool Children

Rauscher, Shaw, Wright, Dennis, and Newcomb hypothesized that music training significantly and specifically enhances spatial-temporal reasoning in young children (Neurological Research '96). They studied seventy-eight children between the ages of three and four divided into three groups. Thirty-four children received private piano keyboard lessons, twenty received equally frequent private computer keyboard lessons, and twenty-four served as other controls, receiving either singing lessons (N=10) or no special lessons (N=14) for six months. Four standard age calibrated spatial-temporal reasoning were given before and after training. One test measured spatial-temporal reasoning, and the other three tests assessed spatial recognition. Post-treatment test scenes showed significant improvement on the spatial-temporal test only for the group that received keyboard lessons. No group improved on the spatial recognition tests. The fact that the computer group showed no effect provides a control for extra attention, involvement, etc. The authors suggest that the improvement of the keyboard group in spatial reasoning could be related to the linear spatial layout of the keyboard. They propose that keyboard training may enhance the learning of standard subjects, such as mathematics and science, in which spatial-temporal reasoning is particularly important

Hard Data at the Shawnee Mission

David Circle from the Shawnee Mission school district in Kansas addressed complaints from non-music school personnel about pulling students out of their regular classes to attend afternoon music classes. The music department has defended the program based on the conviction that the better students are the ones who elect to participate in the program and their academic learning is not impaired as a result of their participation. Some claims have been made that there is a cause-effect relationship between students' higher achievement in the basics and participation in instrumental music.

The music department at the Shawnee Mission school district decided to test their belief that the better students are participants in the elementary instrumental music programs. They provided their testing and data processing department with the names of all sixth grade instrumental music students. The person in charge of the department deleted from the list those students who had not taken the reading and math achievement tests in their district for both the third and sixth grade. This provided them with an intact group of five-hundred and fifty-four students whose total education experience between the two testing periods was within the Shawnee Mission.

Next, they calculated their mean scores and compared them to the mean scores of the intact general population of sixteen-hundred and eight students. The results that they had found were hard data that the instrumental music students' academic achievement is higher than that of the general population. In addition, the instrumental music are included in the mean scores of the general population. Therefore, because the music students' scores are higher, that increases the the mean scores of the general population as well.

Group	**No. students**	**Reading**		**Math Concepts**		**Math Problems**	
Grade	Sample	3RD	6TH	3RD	6TH	3RD	6TH
Music	554	79	78	78	83	79	75
General	1608	79	78	78	83	79	75

Art Education and Academic Achievement

Art education leads to academic achievement. (Music is an integral part of all arts education.) An educational research firm, CEMREL, Inc., has issued a report in 1980 which concluded that in sixty-seven specific studies made in California, student achievement in reading, writting, and math improved when the arts were included in the curriculum (Milley, Buchen, Okerlund, and Mortarotti, 1983). In an arts enriched instruction, a music accompaniment to reading a foreign language produces accelerated learning

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Music Education and Academic Achievement

Music education has a positive effect on providing opportunities for academic achievement. High school music students have been shown to hold higher grade point averages than non-musicians in the same school in a 1981-82 study at Mission Viejo High School in California (Horne,1983). It should be noted that in order to successfully audition for membership in high school performance classes, skills must be developed in previous years. Ideally, these developmental skills are acquired in the elementary grades.

The study of music produces the development academic achievement skills. A 1981 survey revealed that forty percent of the Westinghouse Science Talent Search winners were accomplished musicans.

Dr. Frank R. Wilson, assistant clinical professor of neurology at the University of California School of Medicine, San Francisco, reports that learning to play a musical instrument helps students to develope faster physically, mentally, emotionally, and socially. He states that research shows instrument practice to enhance coordination, concentration, memory, improvement of eyesight, and hearing acuity is possible. He concludes that learning to play and instrument progressively refines the development of the brain and the entire neuromuscular system (Mueller, 1984). He organized the International Conferences of Biology of Music Making, which bring together professionals in music, the biologic and health sciences for a sharing of current thought and findings in science and music. The topic of the 1987 was "Music and Child Development." Music advocates are encouraged by the work of the conferences, which support continuing research into the connection between music educaiton and brain development.

Dr. Georgi Lozonov, founder of accelerated learning at the Instituted of Suggestology, has found that music in a special program of instruction produces accelerated learning. In Bulgaria, his program allows students to complete two years of curricula in four months. First graders can learn how to read and write within a few weeks and third graders study intermediate level algebra. His work is being duplicated presently in the United States (Delehanty, 1983). At California's Paradise Elementary school, the School Experiment in Acclereated Learning Program of 1981-82 and 1982-83 resulted in an improvement in achievement for students in reading and math, as well as in writting and composition.

There is a relationship between high self-perception , high cognitive competence scores , general self-esteem, and interest in school music. In a study by the Norwegian Research Council for Science and the Humanities, a connection was found between students having musical competence and high motivaiton to achieve success in school. Students with interest and competence in school music were found to have a positive correlation with cognitive competence scores.

Studies have shown that achievement in school music builds student self-image which is a motivation for academic learnig among urban black middle school students (Marshall, 1978). Music lessons can lead to interest in academics. Underachieving, disadvantaged youth were given music lessons and developed improvement in their academic attitude and aspirations; they were motivated to learn academic subjects (Olanoff and Kirschner, 1969). An ESAE Title One program to improve academic achievement found that students who had participated in keyboard lessons scored higher on mathematics and history than students who had not, although their IQ scores were not higher than that of other students.

Music games teach fundamental concepts. Dr. Lassar Golkin found that some children who are unable to learn concepts in a school setting are able to easily learn the same concepts through street play games. He developed the Interdependent Learning Model (ILM) which brings music games into schools for the purpose of teaching academic skills and content (Hillery, 1979).

Realaxation through music is seen to be a factor in achievement for children. The American

Psychological Association carried out a meta-analyzes research project of relaxation in which the conclusions of twenty studies revealed the positive effect on cognitive academic variables among elementary school children through progressive relaxation through music (Moon, Render, and Pendley, 1985).

Music education allows disabled students to achieve signigicantly. A three-year Arts in Educaiton project in five elementary schools in the Clover Park School District, Tacoma, Washington demonstrated that when basic academic skills were learned through music, a consistent gain of achievement score points was made. Music was found to be highly useful in teaching perperual skills, and brought greater interest in language development. Achievement in music performance allows mentally disabled students to achieve in other areas as well. Music education, performance, and therapy used to treat the disabled help them to develop self confidence. This confidence leads to other achievements (Reingold, 1987).

Singing plays a large part in the curriculum of primary grade students because singing a lesson helps students to learn. In a study of Dolch Sight Words, instruction for kindergarten students, the teacher sung the words to Group A students but not to Group B. With the exception of the singing, the lessons were exactly alike. Group A learned more words than Group B (Blackburn, 1986).

Music and Pre-learning

Music is found to have a positive effect in pre-learning activities. Premature babies who listen to music have enhanced cognitive ability which may be lasitng. Recordings of classical music were included in a program of special care for premature babies in a study by the University of Florida College of Medicine. The study concluded that babies recieving the special care program had significantly higher mental and physical development than infants who had not recieved the care. In 1981-82, the California Arts Council contracted with the Educational Testing Service to run comprehensive tests on the impact of arts on pre-learning skills. For each of five years since 1976, basic skills have been shown to increase when the arts are added to the curriculum.

Music in Reading Instruction

Music education serves as a tool in leading students to achieve in specific academic subjects. Reading curriculum which includes music can bring an increase of student scores of reading achievement tests. A Title One reading program at Public School No. 1 in Brooklyn, New York included music and the arts in the curriculum. The results were some dramatic rises in student reading achievement test scores (Walker, 1982).

Low achieving readers learn to read when music and the realated arts are in the reading curriculum. In a study involving more than 13,000 students in forty-three schools, the ESEA Title One Evaluation Report for the Whichita Program for Educaitonally Deprived Childern found gains were made in the corrective reading program when music and the related arts were used in the reading curriculum (Walker, 1982).

The PALS Project (Art as a Learning Strategy) followed the success of LTRTA. The project involved a well-planned curriculum which included music and a longitudinal study with carefully drawn conclusions. Students in this program out-achieved those not in the program, when all were tested in reading proficiency (Milley et al., 1983).

An evaluation in achievement in reading and math of elementary school students revealed that in reading for meaning, fifth instrumental music students achieved at a higher level than their non-music student peers. Educators agree that music education is beneficial to reading achievement. Music has been shown to be such an effective component to reading instruction that teachers of reading are now being urged to become competent instructors of music.

Music and Math Achievement

Art Harrell, director of music for public schools in Wichita, Kansas reported on a project in which 13,000 children in fory-two schools entered an ESEA Title One program of additional art, music, physical education, and industrial arts class with enrichment and counseling. He found that students who recieved school keyboard lessons scored higher in mathematics than students not in the program.

The California Arts Counsel's Alternatives in Education programs (AIE) has been in selected schools since 1976. Arts have been found to make a cognitive impact. When music periods have been increased, children have made an average gain of one and one half times the normal rate in math (.75 years in six months) (Maltester, 1986).

IQ scores and achievement test scores are often used to measure student potential and competency. A study an arts enriched language program found a positive effect on the attitude and IQ of second grade students. A study of children in Albuquerque, New Mexico public schools demonstrasted that in all areas of comparison of scores on the California Test of Basic Skills, fifth graders who were enrolled in instrumental music classes scored higher than their peers who were not enrolled. The longer pupils were enrolled, the better they achieved. In 1979, students with two or more in a band scored ten percent higher in language than the others. Those students in music programs for two or more years scored consistently higher than those who participated only one year.

Japan's practices in incorporating music in their school curriculum

In Japan, the history of public school music is short compared to the United States. Established through the School Education Act of 1947, the school music program was modeled after that in effect in the United States at that time. Today in Japan, it is mandated by the Ministry of Education that every child, grade 1-9, receives two hours a week of sequential music instruction from a music specailist. The instruction, in all elementary and junior high schools, from its inception to its completion, is centred on the appreciation of music and the expression or music making.

Every school in Japan is equipped with the instructional materials and instruments needed to enable the teacher to do his or her job thoroughly. These materials and equipment include a complete curriculum, song books, rhythm instruments, a piano, a desk top keyboard for each student, and many other supplimentary teaching and learning aids. Each school building has a room exclusively dedicated to music instruction.

Music is part of the school facility and is an integral part of the basic education curriculum for the first nine years of schooling. In addition, opitonal music instruction such as ensembles, choruses, band and orchestra area given at the school after hours.

The momentum of music as a central and essential part of a young person's school day is growing and now spreading rapidly to emerging and maturing societies throughout the world. And this is not to mention the growing, active fostering of music outside the classroom by parents in many Eastern and Western countries.

In Japan, the Ministry of Education expresses their preoccupation with music education this way; "Our goal is to inspire the children's interest and concern for music and to foster, through the study of music, an attitude and custom of music appreciation and expression that will enrich their entire lifetime." In Japan, the lifetime aspect of music is central to their rationale for music in schools

Summary

It is clear that there is much evidenct to support the importance of music education in the public school system. Music education can be helpful to students who are learning how to read and do math problems for the first time. Music can also give infants a head start on their cognitive development. It has been shown through the previous examination of the current literature, that music education should be a central part of the education of our youth. Other countries like Japan have already recognized its importance and it is time for the United States to catch up with the rest of the world.

Chapter Three-Design of the Study

At this point, the need and purpose for this study have been established and discussed in chapter one. Also, the hypothesis has been stated and an extensive review and discussion of the theory behind the subject matter of the research has been conducted. These theories include musical, spatial, and mathematical intelligence and how they develope and relate to each other in the cognitive workings of the human brain. Finally, the assumptions and limitations of the research were identified along with the necessary definitions of terms that apply to the study. In addition, the literature pertaining to this research in terms of similar studies that have been conducted has been scrutinized in chapter two.

In this chapter, the specifics of the study will be described in detail. The nature of the sample will be specified. The nature of the devices used for measuring the characteristics being studied will be discussed. The design used at arriving at the probability statements about the variables that will be incorporated in the study will be discussed. The hypotheses will be put into testable form. The models that will be used to test the hypothesis will be designated. Finally, a summaary of the chapter will be provided.

Sample

Half of the sample population that was tested came from a group of undergraduate psychology students at a major university. Most of the students came from middle class backgrounds and come from all regions in the state of New Jersey. The age range of the group is 18-22 and the average age was 20. Males made up 40% of the group and females made up the remaining 60%. Twenty students were tested in this group and none of them had any extensive musical training in the past.

The second half of the sample population also came from the same university and were undergraduate music students. All of the students in this group have had extensive musical training since childhood. Similar to the students in the control group, most of the subjects came from middle class backgrounds and live in all regions in the state of New Jersey. The age range for this group was 18-22 and the average age was 20. Males made up 20% of the group and females made up the remaining 80% of the sample. Twenty students from this group were tested and all of them have had enough musical training in the past to enable them to proficiently play a musical instrument with little of no difficulty.

Measures

A major component of the research study incorporates the use of the Differential Aptitude Test (DAT), level two, form C. Therefore, it is important to mention the standardization procedures that were used in order to validate the norm-referenced scores which the raw scores of the participants will be converted. In the following sections, the normative sample, reliability, and validity of the DAT will be discussed along with reliability estimates and limitations of the sample used in this study will also be discussed.

Norms

In order to obtain normative data and to establish statistical reliability and validity of the test, national research programs were conducted. These programs involved several separate phases; fall and spring standardization programs, adult standardization, equating of forms, equating of levels, and validity research including establishing a relationship between the fourth and fifth editions of the DAT. For the purpose of this research, we are only interested in the last four procedures.

The adult standardization program was done in order to represent adults in four types of educational programs; community colleges, vocational/technical school programs, ABE/GED programs, and prison programs. The sample was drawn from state mailing lists for state, national, and local correctional institutions. Level two of the DAT was administered to approximately 2000 students representing two thirds of the programs in seventeen states. Demographic characteristics of the adults who took the DAT are listed in table one.

Reliability

Reliability refers to the accuracy and precision of the test scores. The Kuder-Richardson procedures yield an estimate of accuracy as indicated by the internal consistency of the items in a test. Kuder-Richardson Formula #20 (KR#20) reliability coefficients are reported in table 2.

The purpose of the equating of forms program was to equate scores on the two forms of both levels of the DAT and to establish the alternate form reliability of each test. Schools participating in the study administered the appropriate level of both forms C and D of the DAT to approximately 8000 students in grades 8 and 11. The test was divided into two parts and students took both parts of the two forms at the same level. The order of the administration of the forms was counter-balanced by classroom to exclude practice effects.

The fifth edition of the DAT incorporates the use of two levels which allows for tests that are appropriately targeted for difficulty for junior high school and senior high school students as well as adults. It is necessary to develope a continuous score scale from one level to another that permits interpretation of scores across both levels. The program to accomplish this involved 1100 students in grades 9 and 10. Each student was administered form C of both level one and two. The DAT was divided into two parts and students took both levels of the same part.

Validity

Validity refers to the extent to which the test measures what it is intended to measure. Two issues are relevant: The extent to which the test items actually represent the defined goals of the test (content validity), and the extent to which the test represents the theoretical construct it is intended to assess (construct validity). A third relevant issue is the extent to which the test is related to defined criterion measures (criterion-related validity). Table 4 presents correlations between the DAT Fourth Edition, and the DAT, Fifth Edition. These data provide evidenct for the new edition, since they demonstrate the sound relationship between it and the previous edition.

To establish the validity of the Fifth Edition of the DAT, a study was conducted in order to establish a relationship between the Fourth and Fifth Editions. The schools participating in the study administered the appropriate level of Form C of the Fifth Edition with Form V of the Fourth Edition of approximately 3000 students in grades 8 and 11. The two editions were divided into two parts and students took the same part of the two editions. The order of the administration was counterbalanced to eliminate practice effects.

An important part of the research of the DAT involves demonstrating the relationship between the DAT and other measures of the same related constructs. For the Fifth Edition of the DAT, the relationship was established to other group-administered aptitude tests, to other ability and achievement tests, and to grade-point averages and course grades. All school districts, as well as basic education, vocational/technical schools, community college, and prison programs were asked to provide the students' scores on a variety of achievement tests. Information on grade-point averages and course grades were also collected.

Sample's Reliability and Limitations

The two samples being used in the study are aimed at representing the overall population of which the research is concerned. The first group should be similar to the community college group which the DAT was normed. Although this group is as similar as possible given the experimenter's resources there are some limitations. The group is from a four year university as opposed to a two year college and therefore, there will be some disparity among the two. For instance, career goals, grade point average, family background, and age may differ. The second group must represent a population that is similar to the first except that this group will have several years of musical training and a working knowledge of musical proficiency. A four year university music class will be used for this group to ensure that the participants in this group have the musical training required for the criteria of the musical group.

Design

The independent variables are musical training (experimental) vs non-musical training (control). The dependent variables are the mean scores on the numerical reasoning and spatial relations sections of the DAT. In addition, for the other hypothesis the mean scores for the spacial relations section will be the independent variable and the mean scores on the math section will be the dependent variable. The two sections of the test will be administered to both groups and the scores will be correlated to their respective groups. Also, the group with the higher spatial relations scores will be correlated to the same group's mean math score if it is higher than the other group's mean score.

Testable Hypotheses

There are three null hypotheses that will be considered along with their directional alternates. These are listed below with their symbolic equivalents and accompanying legend:

Legend

Sm1= Mean of the spatial relations test scores for the musically trained group.

Sm2= Mean of the spatial relations test scores for the non-music group.

Mm1= Mean of the mathematical test scores for the musically trained group.

Mm2= Mean of the mathematical test scores for non-music group.

Null Hypothesis: No difference will be found in spatial relations ability as measured by the test scores between the musically trained group and the non-musically trained group.

Ho= Sm1=Sm2

Alternate Hypothesis: The mean test score for spatial relations ability of the musically trained group will exceed that of the non-musically trained group.

H1= Sm1>Sm2

Null Hypothesis: No difference will be found in mathematical ability as measured by the mean test scores between the musically trained group and the non-musically trained group.

$$\mathbf{Ho = Mm1 = Mm2}$$

Alternate Hypothesis: The average test score for mathematical ability of the musically trained group will exceed that of the non-musically trained group.

$$\mathbf{H1 = Mm1 > Mm2}$$

Null Hypothesis: Higher mean scores for spatial relations ability for one group will have no predictive value for higher mean scores for mathematical ability for the same group.

$$\mathbf{Ho = Sm1 > Sm2 = Mm1 > Mm2}$$

Alternate Hypothesis: Higher mean scores for spatial relations ability for one group will be a predictor for higher mean scores for mathematical ability for the same group.

$$\mathbf{H1 = Sm1 > Sm2 = Mm1 > Mm2}$$

Analysis

The scores on both sections of the test for both groups will be correlated using paired and independent t-tests. It is hypothesized that there will be a significant correlation between the musical group and higher mean test scores. It is also hypothesized that the group with higher spacial relations scores will significantly correlate to higher math score means for the same group as compared to the control.

Summary

In this chapter, the nature of the sample has been specified including the population it came from, sex, age range, geographical location, and other important factors. The nature of the test used to measure the skills of interest for this research has also been examined including norms, reliability, and validity. The design of the study has been discussed along with the testable hypotheses and the appropriate analysis to be used to correlate the data.

Chapter Four-Analysis of Results

The hypothesis that musical training has a specific positive effect on spatial relations ability and in turn, has a direct effect on mathematical aptitude was stated in chapter one. Subsequently, in chapter three, the null hypothesis and their alternates were outlined in sentence and symbolic form for analysis purposes. This chapter serves to summarize the results of the research and apply it to these hypotheses which will be restated.

Hypothesis One

Null

No difference will be found in spatial relations ability as measured by the test scores between the musically trained group and the non-musical group.

Ho= Sm1=Sm2

Alternate

The mean test score for spacial relations ability of the musically trained group will significantly exceed that of the non-musical group.

H1= Sm1>Sm2

The mean for the musically trained group was 4.7 points higher than the mean for the non-musical group. An independent t-test was used to test the significance of the difference between group means. The mean differences were significant (T38=2.42). As a result of the findings, the null hypothesis was rejected and the alternate accepted. A detailed outline of the t-test results and group statistics is provided in figures 4.1 and 4.2

Figure 4.1

Independent Samples Test

Var. 2	**t**	**df**	**Sig.**	**Std. Err**	**95% Confidence Interval** **Lower**	**Upper**
Space Rel.	2.42	38	0.02	1.95	0.76	8.64

Figure 4.2

Group Statistics

Group	**N**	**Mean**	**Std. Dev.**	**Std. Error**
Musical	20	32.9	7.4	1.7
Non-musical	20	28.2	4.5	1.0

Hypothesis Two

Null

No difference will be found in mathematical ability as measured by the test scores between the musically trained group and the non-musical group.

Ho= Mm1=Mm2

Alternate

The mean test score for mathematical ability of the musically trained group will significantly exceed the mean score of the non-musical group.

H1= Mm1>Mm2

The mean for the musically trained group was .50 points higher than the mean for the non-musical group. An independent t-test was calculated to test the significance of the difference between the two groups. The difference was not significant (T38=.43). As a result of these findings, the alternate hypothesis was rejected and the null accepted. A detailed outline of the results are outlined in figures 4.3 and 4.4.

Figure 4.3

Independent Samples Test

Var.	t	df	Sig.	Lower	Upper
Math	-0.43	38	0.67	-2.86	1.86

Figure 4.4

Group Statistics

Group	N	Mean	Std Dev.	Std Err.
Music	20	24.5	4.1	.92
Non-music	20	26.0	3.2	.72

Hypothesis Three

Null

Significant mean scores for spatial relations ability for one group will not correlate to significant mean scores for mathematical ability for the same group.

Ho= Sm1>Sm2=Mm1>Mm2

Alternate

Significant mean scores for spatial relations ability for one group will correlate significantly to mean scores for mathematical ability for the same group.

H1= Sm1>Sm2=Mm1>Mm2

A paired sample t-test was calculated to test the significance of the correlation between the spatial relations means and the mathematical ability means for the same group. A significant correlation was found between means for spatial relations and mathematical ability at the .01 level. Therefore, the null hypothesis was rejected and the alternate was accepted. A detailed outline of the results are summarized in figure 4.5.

Figure 4.5

Paired Sample Test

		Paired Differences		95% Confidence Interval	
Var 1-	**t**	**Mean**	**Dev.**	**Lower**	**Upper**
Var 2	-5.28	-4.80	5.75	-6.64	-2.96

Figure 4.6

Paired Sample Correlation

Var 1 &	**N**	**Correlation**	**Significance**
Var 2	40	0.48	.002

In summary, the mean scores on both sections of the test were higher for the musically trained group than those for the non-musical group. However significance of the differences was only found for the spatial relations scores and not the math scores. These results were cause for acceptance of one alternate hypothesis and one null hypothesis respectively. In addition, a significant positive correlation was found for hypothesis three which suggests that there is a correlation between spatial relations scores and math scores. These results were cause for acceptance of the alternate hypothesis for this case.

Chapter Five-Summary and Conclusions

Howard Gardiner states in "Frames of Mind" that there are seven forms of intelligence. Musical, spatial, and mathematical intelligence are among the seven that he included in his theory and are the focus of this research. The purpose of the research is to lend support to the idea that musical training has a positive effect on space relations and mathematical ability. There is a need for the type of research in order to keep music programs alive in the public school system as well as inspiring new research that may lend support to the use of musical techniques and principles to facilitate learning.

There is clear evidence to support the importance of music education in the school system as seen in the literature review. There is research to support theories that suggest that music improves reasoning in pre-school children, positively affects pre-learning, aids in academic achievement such as; reading instruction, math achievement, and is an important aspect of the school curriculum in Japan. It has been shown through the previous examination of the current literature that music education should be a central part of the education of our youth. Other countries, like Japan, have already recognized its importance and it's time for the United States to catch up with the rest of the world.

The sample population consisted of a total of 40 students at a major state university. Half were enrolled in an introductory undergraduate psychology course. The second half came from an undergraduate music class. The average age of the sample was twenty years of age. The Differential Aptitude Test was used to measure the space relations and math abilities of the sample.

The D.A.T. was normed on 2000 students representing two-thirds of the community college, vocational/technical, ABE/GED, and prison programs in seventeen states. The reliability was tested using the Kuder-Richardson Formula (KR-20). Split-half reliability was used to equate forms C and D on 8000 students in grades 8 and 11. Criterion-related validity was used to test the validity of the D.A.T. on 3000 students in grades 8 and 11. Test scores were compared to scores on other ability and achievement tests, grade-point averages, and course grades.

The sample used in the research had some limitations. The used in this particular research was from a four-year university as opposed to a two-year college which the D.A.T. was normed. Career goals, grade-point averages, family background, and age may have differed from the norming population.

The independent variables are musical training (experimental) and non-musical training (control). The dependent variables are the mean scores on the space relations and numerical reasoning scores of the D.A.T. Also, mean scores for space relations was the independent variable and math scores the dependent variable for the hypothesis and correlated. Independent and paired t-tests were used for the purpose of analysis of the variables in each of the three hypothesis.

Significance was found for two of the three hypotheses. The first alternate hypothesis, which stated that mean scores for spatial relations for the musical group would exceed those of the non-musical group, was significant at the .05 level and was accepted. The second hypothesis, which referred to the mean scores for mathematical ability of the musical group would exceed those of the non-musical group was not significant and was rejected. The third alternate hypothesis which stated that there would be no correlation between higher spatial relations scores for one group and higher math scores for the same group was significant at the .05 level and was accepted.

Conclusions

1. Musical training increases spatial relations ability
2. There is a direct correlation between spatial relations ability and mathematical ability
3. There is no correlation between musical training and mathematical ability

Discussion

The results of the research have lent support to the theory that musical training can have a positive effect on spatial relations ability. In addition, a correlation has been found between spatial relations ability and mathematical ability. However, there has been no significance found between musical training and mathematical ability. One possible reason for the lack of evidence for a correlation between musical training and mathematical ability could be tied to the research procedure itself. The non-music group had a break in between tests but because of time constraints, the musical group tested straight through. The math ability tests were administered immediately after the spatial relations test which could have caused the students to become fatigued by the time they reached the math section of the test.

Implications for further research

Anyone wishing to replicate this research will probably get the same results. However, the rejection of the second hypothesis could probably be avoided if the researcher expands testing sessions over time. The lower performance on the math section was most likely a result of fatigue on the part of the subjects. This study should be equal among all testing sessions to ensure accurate results.

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Appendix A

TABLE 1. Demographic Characteristics of the Adult Groups Participating in the *Differential Aptitude Tests* Adult Standardization Program.

Variable	ABE/GED Group N=295	Vocational/ Technical Group N=198	Prison Group N=1130	Community College Group N=332	Combined Group N=1955
Gender					
Male	46.8%	37.9%	76.5%	38.6%	61.6%
Female	53.2%	62.1%	23.5%	61.4%	38.4%
Age					
50+	6.1%	8.1%	5.7%	6.3%	6.1%
40–49	14.2%	10.1%	15.8%	13.5%	14.6%
30–39	29.5%	28.3%	39.1%	16.3%	32.7%
20–29	37.0%	36.3%	34.9%	43.4%	36.8%
19	13.2%	17.2%	4.5%	20.5%	9.8%
Race					
White	73.6%	88.4%	34.0%	69.0%	51.4%
African American	17.3%	—	36.6%	3.0%	24.3%
Asian	3.0%	1.0%	0.6%	3.0%	1.4%
Native American	—	1.0%	1.9%	0.6%	1.3%
Hispanic	1.0%	2.0%	15.1%	9.9%	10.8%
Other	1.4%	2.0%	3.6%	2.4%	2.9%
No Response	3.7%	5.6%	8.2%	12.1%	7.9%
Geographic Region					
Northeast	15.6%	—	8.5%	—	7.3%
Midwest	9.8%	78.3%	7.3%	45.5%	21.4%
Southeast	73.2%	—	39.9%	—	34.1%
West	—	10.6%	44.3%	46.7%	34.6%
No Response	1.4%	11.1%	—	7.8%	2.6%

TABLE 2. Kuder-Richardson Formula #20 Reliability Coefficients, Standard Errors of Measurement, and Related Data for the Level 2 Adult Standardization Sample (continued).

COMMUNITY COLLEGE GROUP
Form C

Test/Total	Number of Items	N	Mean	S.D.	r_{tt}	SE_m
Male						
Verbal Reasoning (VR)	40	61	25.8	9.3	.93	2.5
Numerical Reasoning (NR)	40	62	21.1	9.0	.92	2.6
Abstract Reasoning	40	60	19.2	9.0	.92	2.5
Perceptual Speed & Accuracy	100	60	58.8	19.2	NA*	NA*
Mechanical Reasoning	60	61	43.7	10.5	.92	3.0
Space Relations	50	61	28.3	11.5	.94	2.9
Spelling	40	62	25.6	9.7	.94	2.5
Language Usage	40	61	23.9	9.1	.92	2.6
Scholastic Aptitude (VR + NR)	80	60	46.6	16.4	.95	3.7
Female						
Verbal Reasoning (VR)	40	120	26.8	8.0	.90	2.6
Numerical Reasoning (NR)	40	116	18.9	7.4	.87	2.7
Abstract Reasoning	40	120	17.1	7.1	.86	2.7
Perceptual Speed & Accuracy	100	119	62.6	18.0	NA*	NA*
Mechanical Reasoning	60	121	34.0	8.7	.84	3.4
Space Relations	50	121	23.3	10.7	.92	3.0
Spelling	40	121	27.9	8.8	.93	2.4
Language Usage	40	121	27.8	7.4	.89	2.5
Scholastic Aptitude (VR + NR)	80	116	45.7	13.6	.92	3.8
Combined						
Verbal Reasoning (VR)	40	181	26.4	8.5	.91	2.6
Numerical Reasoning (NR)	40	178	19.6	8.1	.89	2.7
Abstract Reasoning	40	180	17.8	7.9	.89	2.6
Perceptual Speed & Accuracy	100	179	61.3	18.5	NA*	NA*
Mechanical Reasoning	60	182	37.3	10.4	.90	3.3
Space Relations	50	182	25.0	11.2	.93	2.9
Spelling	40	183	27.2	9.2	.93	2.4
Language Usage	40	182	26.5	8.2	.91	2.5
Scholastic Aptitude (VR + NR)	80	176	46.0	14.6	.93	3.8

*NA = Not applicable.

TABLE 4. Intercorrelations Among Raw Scores for the *Differential Aptitude Tests*, Fifth Edition, Form C, and Fourth Edition, Form V.

Test/Total	Variable	Level 2 1	2	3	4	5	6	7	8	9
Male (N = 348)										
Verbal Reasoning (VR)	1	.83								
Numerical Reasoning (NR)	2*		.78							
Abstract Reasoning	3			.68						
Perceptual Speed & Accuracy	4*				.49					
Mechanical Reasoning	5					.77				
Space Relations	6						.79			
Spelling	7							.79		
Language Usage	8								.80	
Scholastic Aptitude (VR + NR)	9									.87
Female (N = 279)										
Verbal Reasoning (VR)	1	.84								
Numerical Reasoning (NR)	2*		.80							
Abstract Reasoning	3			.73						
Perceptual Speed & Accuracy	4*				.52					
Mechanical Reasoning	5					.73				
Space Relations	6						.79			
Spelling	7							.85		
Language Usage	8								.82	
Scholastic Aptitude (VR + NR)	9									.88
Combined (N = 627)										
Verbal Reasoning (VR)	1	.84								
Numerical Reasoning (NR)	2*		.78							
Abstract Reasoning	3			.70						
Perceptual Speed & Accuracy	4*				.52					
Mechanical Reasoning	5					.80				
Space Relations	6						.79			
Spelling	7							.82		
Language Usage	8								.82	
Scholastic Aptitude (VR + NR)	9									.87

*For the *Differential Aptitude Tests*, Fourth Edition, Form V, these tests are titled Numerical Ability and Clerical Speed and Accuracy.

Intercorrelations Among Tests

Intercorrelations among the tests for Level 2 of the DAT are presented in Table 5. These data are based on raw scores of students in the spring of Grade 11. These correlations can be helpful to the counselor since they provide information about the interrelationships among the tests in the DAT.

TABLE 5. Intercorrelations Among the Level 2 *Differential Aptitude Tests.*

Test/Total	Variable	Form C 2	3	4	5	6	7	8	9
Male (N = 1357)									
Verbal Reasoning (VR)	1	.75	.68	.29	.57	.62	.63	.72	.93
Numerical Reasoning (NR)	2		.71	.31	.52	.62	.60	.69	.94
Abstract Reasoning	3			.29	.64	.71	.44	.58	.74
Perceptual Speed & Accuracy	4				.24	.23	.26	.31	.32
Mechanical Reasoning	5					.61	.30	.48	.58
Space Relations	6						.40	.53	.66
Spelling	7							.72	.66
Language Usage	8								.76
Scholastic Aptitude (VR + NR)	9								
Female (N = 1433)									
Verbal Reasoning (VR)	1	.70	.64	.11	.57	.59	.56	.67	.92
Numerical Reasoning (NR)	2		.64	.23	.50	.55	.59	.62	.93
Abstract Reasoning	3			.19	.66	.71	.34	.47	.69
Perceptual Speed & Accuracy	4				.15	.14	.15	.17	.19
Mechanical Reasoning	5					.64	.25	.43	.58
Space Relations	6						.28	.41	.62
Spelling	7							.69	.62
Language Usage	8								.70
Scholastic Aptitude (VR + NR)	9								
Combined (N = 2790)									
Verbal Reasoning (VR)	1	.73	.66	.21	.48	.60	.60	.70	.93
Numerical Reasoning (NR)	2		.67	.28	.43	.58	.60	.66	.93
Abstract Reasoning	3			.23	.60	.71	.38	.51	.71
Perceptual Speed & Accuracy	4				.12	.18	.23	.26	.27
Mechanical Reasoning	5					.59	.16	.31	.49
Space Relations	6						.32	.45	.63
Spelling	7							.72	.64
Language Usage	8								.73
Scholastic Aptitude (VR + NR)	9								

TABLE 5. Intercorrelations Among the Level 2 *Differential Aptitude Tests* (continued).

		Form D							
Test/Total	**Variable**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Male (N = 1541)									
Verbal Reasoning (VR)	1	.70	.69	.23	.54	.61	.59	.71	.92
Numerical Reasoning (NR)	2		.72	.27	.42	.57	.58	.66	.93
Abstract Reasoning	3			.30	.59	.70	.46	.62	.77
Perceptual Speed & Accuracy	4				.20	.20	.20	.18	.27
Mechanical Reasoning	5					.63	.29	.44	.52
Space Relations	6						.38	.53	.64
Spelling	7							.72	.63
Language Usage	8								.74
Scholastic Aptitude (VR + NR)	9								
Female (N = 1588)									
Verbal Reasoning (VR)	1	.72	.66	.08	.60	.57	.54	.68	.92
Numerical Reasoning (NR)	2		.71	.18	.50	.53	.50	.64	.93
Abstract Reasoning	3			.18	.63	.66	.36	.57	.74
Perceptual Speed & Accuracy	4				.12	.09	.07	.02	.14
Mechanical Reasoning	5					.65	.28	.48	.59
Space Relations	6						.27	.44	.59
Spelling	7							.58	.56
Language Usage	8								.71
Scholastic Aptitude (VR + NR)	9								
Combined (N = 3129)									
Verbal Reasoning (VR)	1	.71	.68	.16	.51	.59	.56	.68	.92
Numerical Reasoning (NR)	2		.72	.23	.40	.54	.54	.65	.93
Abstract Reasoning	3			.23	.57	.68	.40	.58	.75
Perceptual Speed & Accuracy	4				.06	.11	.18	.15	.21
Mechanical Reasoning	5					.63	.17	.33	.49
Space Relations	6						.29	.45	.61
Spelling	7							.68	.59
Language Usage	8								.72
Scholastic Aptitude (VR + NR)	9								