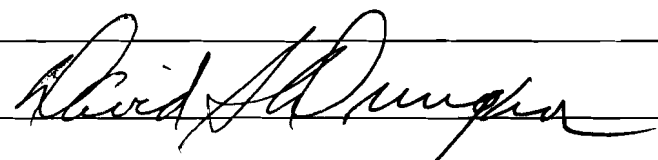
AN ABSTRACT OF THE THESIS OF

Karen Lynn Hayslett for the Master of Science

in Clinical Psychology presented on April 11, 1997

Title: Relationships Between the Arlin Test of Formal Reasoning and the Torrance Test of Creative Thinking

Abstract approved: 

The purpose of this study was to investigate the relationships between the Arlin Test of Formal Reasoning (ATFR) and the Torrance Test of Creative Thinking (TTCT). Additional issues explored were the percentage of the sample group operating at formal operational levels and whether there were significant differences between scores on the two tests that were related to differences in gender. The sample consisted of 60 college students (37 women and 23 men) ranging in age from 18 to 20. Both the ATFR and the TTCT Verbal were administered to each subject. Scores for both tests were recorded for each subject as were age and gender.

Pearson product-moment correlation coefficients were calculated to determine whether a relationship existed between the ATFR Total scores and the TTCT Verbal Total scores. A series of t tests were computed to determine significant differences in performance on the two tests by men and women. Subjects were categorized by the five cognitive levels assessed by the ATFR and the percentage of students operating at each of the five levels was calculated.

The ATFR total scores did not correlate with the TTCT Verbal Total scores. In this sample 48.3% of the participants were found to be operating at the formal operational level of cognitive ability, with 20.0% operating at the transitional level of cognition

between the formal and concrete levels, and the remaining 31.7% were assessed to be at the concrete level of cognitive ability. The number of college students functioning at a concrete level continues to serve as a reminder that these individuals need information presented to them in a concrete fashion to facilitate learning.

Further research is indicated to define whether a relationship exists between creativity and formal operational reasoning. These relationships may occur in areas that are more specific, not as the general creativity and formal operational reasoning constructs used in this study. In addition, it is suggested creativity and formal reasoning may merely be facets on a larger construct and should possibly studied as such. The limitations in generalizability, due to ample size and financial constraints, may warrant additional research to substantiate the findings of this study.

RELATIONSHIPS BETWEEN THE ARLIN TEST OF FORMAL REASONING AND THE TORRANCE TEST OF CREATIVE THINKING

A Thesis

Presented to

the Division of Psychology and Special Education

EMPORIA STATE UNIVERSITY

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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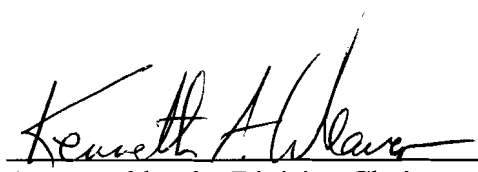
by

Karen L. Hayslett

May 1997



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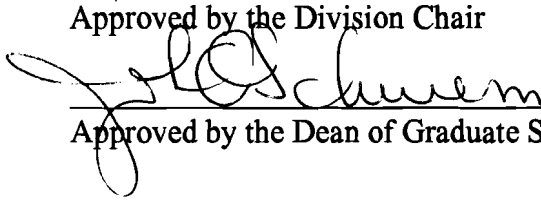

Approved by the Dean of Graduate Studies and Research

ACKNOWLEDGMENTS

I wish to express my sincere gratitude to my committee members, Chairperson Dr. David Dungan, Dr. Kurt Baker, and Dr. Sheryl Nowak. The expertise, encouragement, information and support offered by each one will always be remembered and appreciated.

Deepest thanks also go to my family and my fiancé, Rod McCall, from whom I have received unconditional love, encouragement, and moral support during the pursuit of my degree and through the progression of my thesis. My gratitude is extended to Richard and Dee Anderson, whose assistance at a turning point in my life made this second degree possible. Finally, I wish to acknowledge and thank my friends, Theresa Bolen and Shalon Berry, without whose support my thesis would not have come to such a successful conclusion.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

CHAPTER 1

INTRODUCTION

Formal reasoning, Piaget's fourth and final stage of cognitive development, can be defined as an individual's ability to engage in abstract thought. This type of thought involves the formation of hypotheses about a situation that the individual either accepts or rejects through deduction to choose the best solution. Lay individuals can see this hypothetic-deductive process as a more developed problem-solving capacity. Piaget originally thought the formal operational reasoning stage of development was accomplished between the ages of 11 and 15. Currently, some believe the acquisition of formal reasoning may occur much later than previously believed. P. K. Arlin composed a testing instrument to examine Piagetian thought processes qualitatively, including formal operational reasoning, titled the Arlin Test of Formal Reasoning (ATFR) (Fakouri, 1985).

Related to the thought process is the origination, or creation, of the thought itself. Creativity, as a process, can be perceived as opposite of formal reasoning. Thinking creativity includes the ability to construct divergent and multiple thoughts, not to deduce many possibilities into one option of choice. The Torrance Test of Creative Thinking (TTCT) is an instrument, designed by E. P. Torrance, used to examine some aspects of creativity (Chase, 1985).

As a society, we often view creative thinkers as divergent thinkers, not as hypothetic-deductive reasoners. Little research has been done which examines creativity and the formal reasoning process together. Most research has stemmed from the belief they are separate, distinct skills or processes, and has thus focused on either formal

reasoning or creative thinking.

In this study, the results of the Arlin Test of Formal Reasoning were compared with those of the Torrance Test of Creative Thinking verbal test to learn whether a relationship existed. Gender differences were evaluated to detect whether one gender tended to score higher on one instrument than did the other.

By examining the relationship between these two instruments, this study has the capacity to be of use in many areas. Educational strategies could be designed or manipulated to achieve maximum learning. Clinical psychologists can investigate a client's ability to evaluate, handle, and solve life problems. Problem-solving skills use formal reasoning or creativity; individuals may differ on whether they use creativity or reasoning processes more and may want a more well rounded approach. Further examination of the applications of instrument results may lead to suggestions from developmental researchers to improve problem-solving capacities. Such increased capacities could aid in areas including therapy, personal development, and career enhancement and/or development. Evidence of similarities or differences between the ATFR and the TTCT could provide the basis to examine the extent to which each of these tests measures formal reasoning and creative thinking respectively.

Review Of The Literature

Thinking, learning, reasoning, creating, problem solving, and deciding are processes that are completed every day in a person's life. These processes are taken for granted by most, but for some they are sources of great inquiry. The possession of knowledge and the ability to learn has been of interest for a long time. Current research or

attempts to understand formal operational reasoning and creativity have taken their roots in the ages. Historically, philosophic and scientific thought of the early Greeks was the seed which planted the desire to search human knowledge. According to Plato, every physical object has a corresponding abstract, an idea, that causes it to exist. He believed these ideas are obtained from the "mind's eye," and are a type of recollection from experiences the soul may have previously had in the heavens. Plato's student, Aristotle, developed differing opinions. Aristotle believed sensory experience is the basis of the knowledge we obtain, and that physical objects did in fact exist as just that -- physical objects (Hergenhahn & Olson, 1993).

By the 1600s and the Renaissance period, this search for answers about nature's processes was reborn. Rene Decartes suggested there was a separation of the mind and the body, and furthered this philosophical quest by stating the mind was a uniquely human trait. He is remembered well for the following statement: "I think, therefore I am." Decartes based many of his beliefs on Plato's philosophy and thus conceptualized ideas as innate. Once again the debate was reopened, as Thomas Hobbes, a contemporary of Descartes, opposed the notion of innate ideas. Hobbes reiterated that ideas are derived from impressions gathered by human senses (Hergenhahn & Olson, 1993).

John Locke added fuel to this controversy when he proclaimed ideas can not be innate because they are a product of experience. At birth, Locke believed infants possessed a *tabula rasa*, or minds were as a blank slate. In addition, Locke proclaimed, as did his predecessor Galileo, a differentiation between primary and secondary cognitive qualities. Primary qualities were the familiarly discussed sensory experiences. In contrast,

secondary qualities were separate and purely cognitive in nature (Hergenhahn & Olson, 1993).

Several other prominent philosophers followed in the 1800s with further explanations for the cognitive aspects of the human mind. Complex idea formation from simpler ideas was a concept brought forth by John Stuart Mill, and thus was born the notion that the whole is different from the sum of its parts. Francis Gall is noteworthy for his belief that different cognitive abilities were housed in different locations within the brain. Gall's phrenology led the way to the actual discovery of the functions of parts of the brain, and to the notion that the mind could become stronger with cognitive exercise. Charles Darwin's work on biological evolution connected genetics and experience. Scientific investigation of behavior and the processes behind cognition was becoming popular. Among those influenced by Darwin was Sigmund Freud, a well known developmental stage theorist and an investigator of the human mind (Hergenhahn & Olson, 1993).

Hermann Ebbinghaus demonstrated that the cognitive processes of learning and memory could, in fact, be studied experimentally. Association was studied as a process as it was occurring by this psychologist. Initially, Ebbinghaus performed a preliminary screening on participants. Next, he repeatedly exposed the participants to his now famous nonsense material until mastery had occurred. The learning and retention process was investigated systematically and scientifically. Results were graphed as a function of elapsed time (Hergenhahn & Olson, 1993).

Max Wertheimer, considered to be the founder of Gestalt Psychology, became

interested in investigating education. Learning had been seen as memorized facts being recalled when an individual was questioned about the material. It was a repetitive exposure to, and a consumption of, material with recall occurring sheerly from the rote memory developed by multiple exposures. In his 1945 book, Productive Thinking, Wertheimer stated that individuals understand the nature of the situation, and this was how each problem at hand was solved. If the underlying nature was not understood, then how was a problem to be solved? This was different from other beliefs at the time regarding the traditional beliefs of logic. Interest in learning and reasoning grew, and ideas evolved. (Hergenhahn & Olson, 1993)

During the twentieth century, many theories have emerged from the seeds planted by the pioneers of cognition. Learning, memory, and thinking have been examined from a variety of perspectives. The studies lack consistency because the perspectives vary. However, a large portion of professional literature is dedicated to a Piagetian view of cognition. Of importance to this study is this Piagetian-based literature that regards formal operational reasoning as a stage of human cognitive development. Piaget believed formal reasoning was characterized by an individual's ability to cognitively apply all solutions to a problem by thinking in a deductive and hypothetical fashion (Bart, 1971). In addition, he believed that it was this hypothetico-deductive level of thought that allowed the individual to go beyond the concrete into the abstract (Furth, 1969).

The development of cognition was first assessed using a clinical interview format. Piaget conducted interviews and then made reference to particular protocols in presentations as materials of proof (Inhelder & Piaget, 1958). Ahlawat and Billeh (1987)

regarded this as the preferable manner, because it provided the most useful framework for assessing the cognitive thought of an individual. This method of assessment required a great deal of skill, knowledge, and time on the part of the examiner. A clinician must be confident in both the clinical interview and evaluation, and must have the time to perform evaluations one-on-one with the client. Due to the hindrance of the one-on-one assessment time required by this method, cognitive theorists began searching for another method. They looked for a method that was less time consuming and simultaneously allowed for statistical evaluation of the method itself. An objective method, rather than a subjective one, was preferable. For these reasons, among others, Santmire (1985) stated the development of new tests was necessary. A paper and pencil instrument that could be given to multiple individuals at one time is ideal for the purposes of research. Shayer, Adey and Wylam (1981) stated that the individual interview "effectively [rules] out the collection of large quantities of data typically required by research and survey programs" (p. 157).

Creating a paper and pencil test that stands up to theory is quite a task. Piaget's theory of cognitive ability is based on human developmental stages. Researchers need a method that measures this concept in a standardized fashion. Examiners want results that are assessable "directly in terms of Piagetian level, rather than by direct inference from total test score" (Shayer et al., 1981, p. 158). According to Shayer et al., there are several paper and pencil tests that combine psychometric testing with the measurement of those abilities that originally assessed by Piaget's interview method.

<u>The Assessment of Formal Reasoning</u>

Lawson (1978) developed and tested the Classroom Test of Formal Reasoning (CTFR). This instrument was designed to measure cognitive operations in the isolation and control of variables, proportional reasoning, probabilistic reasoning, and combinational reasoning. Initial results of Lawson's study implied that the CTFR was a valid test of formal reasoning. Pratt and Hacker (1984) conducted a study to assess the original CTFR and a modified version. This study used 136 college students and concluded that the instrument did not provide a valid measure of formal reasoning. Next, Hacker (1989) followed up with a study that used 201 junior high school students. It was concluded from the results that the CTFR again lacked validity.

Tobin and Capie (1981) developed the Test of Logical Thinking (TOLT) . It was designed to measure the following: controlling variables, proportional, combinatorial, probabilistic, and correlational reasoning. An initial problem was some examinees could not clearly justify their answers. An attempt for the correction of this issue was made by Tobin and Capie in 1984. The modified version of the TOLT included multiple choice statements of justification. Criterion-related validity evidence was found, yet the TOLT was still open for similar criticisms as the CTFR because it was based in the CTFR. Ahlawat and Billeh (1987) compared the CTFR, the TOLT, and Longeot's Test of Logical Thinking (LTLT). Earlier studies by Ward, Nurrenbern, Lucas and Herron (1981) and Farmer, Farrell, Clark, and McDonald (1982) had suggested the LTLT was a reliable and valid instrument. Ahlawat and Billeh (1987) contradicted these findings.

The above mentioned tests are not exhaustive of those instruments that have been used in the area of formal reasoning assessment. The Formal Operational Reasoning Test

(FORT) examined by Roberge and Flexer (1979) measured three formal operational skills (combinations, proportional logic, and proportionality). However, the FORT was assessed on seventh and eighth graders. The Inventory of Piaget's Developmental Tasks (IPDT) gave results that are similar in nature to that obtained by interviews according to Patterson and Milakofsky (1980). Also, the Group Assessment of Logical Thinking (GALT) and the Propositional Logic Test (PLT) both have the potential to be valid and reliable assessment instruments according to Piburn (1989). However, each of these has limitations that make them less suitable for the endeavor of this study.

The Arlin Test of Formal Reasoning is normed on an adolescent and an adult population. This instrument measures eight formal reasoning operations and yields an overall formal reasoning index (Arlin, 1982). This test appears to be valid in assessing cognitive developmental operations. It is also normed and can be used to assess the presence or absence of formal operational reasoning in college students.

The Arlin Test of Formal Reasoning has several characteristics that made it stand above others in relation to the needs of this study. It has had several good reviews published (Arter & Salmon, 1987; Fakouri, 1985). Even Santmire's 1985 critical review commented that "the concept of formal operational reasoning is probably robust enough that the total score assessment proved by the ATFR is reasonably well correlated with level of formal operational functioning" (p. 83). Also, the ATFR can be administered to a group in approximately 30 to 45 minutes. It is in a multiple choice format, and can be evaluated objectively. Arlin (1982) stated that the ATFR's "value is in the provision of reliable and valid information about the cognitive levels of groups of individuals so that

information about the cognitive levels and characteristics of large groups of students can be utilized for instructional and curricular decisions" (p. 1087). Due to the favorable reviews and characteristics of the ATFR, it seems natural to utilize it as an instrument in the present study.

Schwebel (1975) found gender differences on a study of logical problem solutions, as men scored higher than did women. In support of this finding, Primeau (1989) found significant differences between genders on the ATFR. Contrary to these findings, Young (1993) found no gender differences on scores obtained on the ATFR. Thus, further study of gender differences on the ATFR are warranted.

Creativity

Creativity as a concept carries with it many different meanings. "The ability to produce new forms in art or mechanics or to solve problems by novel methods" is the definition of creativity in Chaplin's Dictionary of Psychology (1968). Others see creativity as a cognitive process that involves multiple areas of the brain. Some view creativity as an opposing cognitive process to formal reasoning. The former is seen as arts-oriented, whereas the latter is seen as logical and critical. Feldman, Csikszentmihalyi, & Gardner (1994) argued that human beings have the tendency "to intentionally transform their physical and social worlds" (p. 17). They also argued that this creative transformation was a uniquely human process.

The current study employed the Torrance Test of Creative Thinking, and thus reflected a definition of creativity provided by E. P. Torrance. Torrance (1978) defined creativity as:

> A process of becoming sensitive to or aware of problems, deficiencies, and gaps in knowledge for which there is no learned solution; bringing together existing information from the memory storage or external resources; defining the difficulty or identifying the missing elements; searching for solutions, making guesses producing alternatives to solve the problem; testing and retesting these alternatives; perfecting them and finally communicating the results. (p. 146)

This definition identifies many of the keys to identifying individuals who employ creativity. The search for alternative solutions is suggestive of the process of divergent thought that runs throughout the literature on creativity. This concept of divergence suggests the origination of multiple ideas from a single root. Again creativity seems to oppose reasoning, or logic, as the latter is the bringing together of existing knowledge to form one solution.

Of the varied meanings, a central theme emerges that finds synonymous use of the following terms: "gifted, genius, eminent creators, and highly creative persons" (Renzulli, 1978). Many associations between giftedness, or intelligence, have been drawn to creativity. Yong (1994) found scores on verbal creativity measures were related to intelligence, although similar scores for figural creativity were not. McCabe (1991) similarly found a "strong relationship exists between both measure of intelligence and all aspects of creativity" (p. 121).

Renzulli (1978) offered a three-ring conception, or definition of giftedness. The three rings interlock, forming a cluster of three that overlapped in the center. Each ring contained one of the following "ingredients": above average ability, task commitment, and

creativity. Renzulli pointed out that "no single cluster 'makes giftedness'... rather, it is the interaction among [them] that research has shown to be the necessary ingredient for creative/productive accomplishment" (p. 182). The interaction was the area where the three rings connect.

Quantifying human creative achievement or abilities also offers a challenge. In what manner do examiners attempt to measure creativity? What methods are reliable and valid? The Torrance Test of Creativity verbal test (TTCT) is the most widely validated test of creative thinking (McCabe, 1991). Treffinger (1985) and Chase (1985) indicated in reviews that the TTCT can be seen as useful in the assessment of creativity in groups. According to Torrance and Rockenstein (1988), "over 1,000 studies using [this] test have been reported, and a large number of them supply a great deal of validity and reliability data" (p. 288).

Reports of gender differences in creativity scores and abilities are mixed in the literature. DeMoss, Milich, and DeMers (1993) found that females scored higher on verbal creativity scores, than did males. It should be noted that the difference existed only on verbal scores. However, DeMoss et al. went on to report that a "disproportionate number of males are likely to achieve eminence in creative fields ... including verbal domains" (p. 464). This conflicting information is worthy of continued study.

Intelligence has been associated with creativity as well as with formal reasoning. These associations have derived from the demonstrations of reasoning skills and creativity in highly intelligent persons. With the Arlin Test of Formal Reasoning serving as a measure of Piaget's formal operational reasoning stage and the Torrance Test of Creative

Thinking acting as a measure of creativity, the comparison of the two instruments may overlap. The two instruments served as the comparative and focal points of this study. The research questions of this study were directed at determining whether relationships existed between the ATFR and the TTCT, and any portions of these two instruments. In addition gender differences were examined for both instruments.

The research questions of this study are as follows. Does a relationship exist between the overall performances of the Arlin Test of Formal Reasoning and the Torrance Test of Creative Thinking verbal test? Are high scorers on one instrument likely to score similarly high on the other instrument, or are they likely to have scores that fall on the opposite poles? Will gender differences be detected on the performances on the two instruments? Will one gender score higher on the ATFR and the other score higher on the TTCT?

CHAPTER 2

METHOD

The Arlin Test of Formal Reasoning (ATFR) and the Torrance Test of Creative Thinking (TTCT) verbal test were administered to approximately 60 research participants. The ATFR is used as a measure of the Piagetian-based notion of formal reasoning. The TTCT is used as an assessment of creativity. The results of the ATFR and TTCT were compared to determine whether a relationship existed between the instruments. These results were compared within the context of the individual. Gender differences in regards to performances on the ATFR and TTCT were evaluated to decide whether one gender scored higher on one instrument than did the other gender.

Participants

The participants for this study were 60 traditional freshmen and sophomores at Emporia State University. Participants were selected on a first-to-sign-up volunteer basis through the use of a sign-up sheet in the psychology department. Only students ranging from age 18 to 20 were included in the study. This age range was selected, without regard to the confounding factor of maturity, as growth in reasoning skills can occur as a function of time and exposure to tasks. Twenty-three male and 37 female students participated. Mean age of participants was 19.17 years (SD= 0.71).

Informed consent documents were provided to the participants of this study (see Appendix A). This document explained the testing procedures, confidentiality issues, and the participant's right to withdraw from the study at any time. The approval granted by the Institutional Review Board was also noted on the form.

Experimental Design

Correlational research was used to detect whether relationships existed between two or more variables that were being investigated. More specifically, psychometric studies were done to determine relationships between two or more variables of a psychological instrument. The information gathered by a study of this nature is helpful in making more informed and insightful predictions in the future.

This study investigated possible relationships between the ATFR and the TTCT. If a relationship existed in some form, then others would be better able to use this knowledge to predict future outcomes in those specific areas. In addition, this method of research required only the administration of the ATFR and the TTCT, and the collection of demographic data.

Research Questions

Several research questions were enumerated in this study. These questions were directed at determining whether relationships existed between the ATFR, the TTCT, and any portions of these two instruments. In addition, gender differences in each of these areas were examined.

These research questions were as follows: Did a relationship exist between the overall performances on the Arlin Test of Formal Reasoning and the Torrance Test of Creative Thinking Verbal test? Were high scorers on one instrument likely to score similarly high on the other instrument, or were they likely to have scores that fall on the opposite poles? Were gender differences detected on the performances on the two instruments? Did one gender score higher on the ATFR and one on the TTCT?

Procedures

An informed consent form was provided to each participant upon arrival at the designated meeting room. This consent form explained testing procedures, confidentiality issues, and the participant's right to withdraw from the study at any time. The approval of the Institutional Review Board for Treatment of Human Subjects was also noted on the form. Prior to beginning the testing process, each participant was required to read and sign the consent form. Consent forms were collected before answer sheets of either instrument were given to the participants.

Each participant was asked to complete a brief demographic questionnaire. This questionnaire asked for the participant's age, date of birth, gender, and class designation of freshman or sophomore (see Appendix A). At the top of the demographic sheet was a participant number. Answer sheets were labeled at the top right corner with a two-digit code number. This number protected the anonymity of each participant. The numbers ranged from 01 to 60. The answer sheets were marked with matching numbers, in order to insure that each participant's answer sheets and demographic information were kept together.

Both the ATFR and the TTCT verbal test were administered by the author, or by another individual trained to do so in the same manner as the author, according to the instructions provided in their respective manuals. These instruments can be administered in a group setting, and were administered in this fashion. One half of the participants began with the ATFR, and the other half began with the TTCT. The instruments were scored by the author according to their respective manuals.

Instrumentation

The ATFR was the instrument chosen to measure the level of cognitive development according to Piaget's developmental stages. It was used to detect whether a participant had achieved the stage of formal reasoning.

The instrument consisted of 32 multiple-choice items. Each problem was represented pictorially and in printed form. Four response choices were listed after each question. Eight formal concepts were represented and were measured by eight subtests within the 32 items of the ATFR. These eight concepts were (a) multiplicative compensations, (b) correlations, (c) probability, (d) combinational reasoning, (e) proportional reasoning, (f) forms of conservation beyond direct verification, (g) mechanical equilibrium, and (h) the coordination of two or more systems of frames of reference.

Two types of scores can be obtained from the ATFR, a total score and subtest scores for each of the eight formal concepts. To assign a participant to one of the five categories of cognitive ability, the total raw score is used. The five levels of assignment are (a) low concrete, (b) high concrete, (c) transitional, (d) low formal, and (e) high formal. The total score determines the level of assignment. The levels were derived as follows: low concrete range, 0 to 7 points; high concrete range, 8 to 14 points; transitional level range, 15 to 17 points; low formal range, 18 to 24 points; and high formal range, 25 to 32 points (Arlin, 1984). These levels of assignment were based on several revisions that tested over 15,000 students grades 6 through 12 and adult samples. More than 6,500 students were tested with the current version (Arlin, 1984). Santmire's review of the

ATFR in The Ninth Mental Measurements Yearbook (1985) concluded the instrument measured reasonably well correlates to the formal operational reasoning concept.

The TTCT verbal test was the other instrument used in this study. TTCT's verbal test contained seven subtests: (a) Asking, (b) Guessing Causes, (c) Guessing Consequences, (d) Product Involvement, (e) Unusual Uses, (f) Unusual Questions, and (g) Just Suppose. These subtest scores were based on fluency, flexibility, and originality. Scores are accumulated on the subtests and totaled. The totals may be converted to standard scores to obtain a normative reference.

Treffinger's review of the TTCT in The Ninth Mental Measurements Yearbook (1985) reported test-retest reliabilities ranging from .50 to .93, which is reasonably reliable for application to this study. Treffinger also reported that the scores on the TTCT have some support proving predictive validity. Chase's 1985 review, also in The Ninth Mental Measurements Yearbook, stated that inter-subtest correlations were between .74 and .80. These were much higher than the inter-subtest correlations on the figural test of the TTCT. The verbal test was used in this study because of its higher correlations. Cooper (1991) summarized several studies on the TTCT's reliability and validity and stated that it had shown significant reliability and validity in assessing "four mental abilities related to creativity in the context of research and group assessment" (p. 197).

Statistical Design

The data for this study were collected via the completion of the instruments by the volunteer participants. Upon completion, the ATFR and TTCT were scored by the author and the subtests and the totals of the instruments were analyzed. The statistical technique

used to detect whether a relationship existed between the instruments was the Pearson product-moment correlation. This was a concurrent criterion validity study with the two criteria being the overall ATFR scores and the overall TTCT scores. After the Pearson product-moment correlation coefficients were compiled, a t test was applied to the male gender versus female gender scores on the two separate instruments. This was done to detect whether significant difference existed between the two genders' performances. Alpha was set at .05. The dependent variable in the t tests was the scores on the instruments, and the independent variable was the gender. Both the Pearson product-moment correlation and the t test were computed using SPSS statistical software.

CHAPTER 3

RESULTS

The total score on the ATFR was used in determining the level of formal reasoning skills achieved by the participants. The ATFR distinguishes scores in terms of five levels of operational reasoning, Concrete, High Concrete, Transitional, Low Formal, and High Formal. The mean ATFR score was 17.23, with a standard deviation of 4.93. The number of students scoring at each of the five levels of the ATFR was obtained, and then converted into percentages. These results are shown in Table 1.

Only 48.3% of the sample scored in the formal reasoning range of the ATFR (Low Formal + High Formal), with only 5% of the participants achieving the highest possible level of formal reasoning. The 20% of participants who scored at the Transitional level were not considered as having achieved the formal reasoning levels. Collectively 51.7% of participants scored in the low concrete, high concrete, and transitional ranges of the ATFR, yet the highest single percentage of the participants had scored in the low formal reasoning range (43.3%).

The total score on the TTCT was used to determine creativity levels achieved by the participants. The range of scores on the TTCT was 53 to 140. The mean of scores achieved on the TTCT was 77.98, with a standard deviation of 16.91. The relationship between TTCT scores and those achieved on the ATFR was determined by using the Pearson product-moment correlation.

The correlational analysis of score data obtained from the Arlin Test of Formal Reasoning and the Torrance Test of Creative Thinking indicated a slight, but almost

Table 1

Percentage of Participants Scoring at Each of the Five ATFR Levels of Reasoning

Level of Reasoning	N	Percentage
Concrete	1	1.7
High Concrete	18	30.0
Transitional	12	20.0
Low Formal	26	43.3
High Formal	3	5.0

N = 60.

negligible correlation existed between the two measures. The correlation coefficient between these two measures was .16 ($p > .05$) .

In an effort to determine if any statistically significant differences in scores occurred between the mean scores of male participants and female participants on any of the test results obtained in this study, a series of t tests was also calculated. Table 2 presents the results of mean difference tests for the participants when grouped on the basis of gender.

The obtained t values on the test scores from the ATFR used in this study were not greater than or equal to 2.06, the critical t value at the .05 level of significance. The obtained t scores on the test scores from the TTCT used in this study were also less than 2.06. Therefore, significant differences between male and female participants were not found on either the ATFR or the TTCT.

Table 2

Means, Standard Deviations, and t values of the ATFR and the TTCT for Men and Women

Test	Men (N =23) M	SD	Women (N =37) M	SD	t
ATFR					
Total	18.57	5.41	16.41	4.49	1.67
TTCT Verbal					
Total	75.13	15.63	79.76	17.64	-1.03

CHAPTER 4

DISCUSSION

This study was designed to determine whether a relationship existed between the Arlin Test of Formal Reasoning (ATFR) and the Torrance Test for Creative Thinking Verbal (TTCT). Results indicated by the ATFR suggested that 48.3 % of the participants demonstrated formal operational reasoning. Twenty percent of the participants were determined to be operating in the transitional level between concrete and formal reasoning. Another interesting observation of this study was that 31.7% of the college student volunteer participants were found to be operating at the concrete level of Piagetian reasoning according to the ATFR. The proportion of participants was sizable and noteworthy for those involved with the education of such individuals. A concrete thinker needs information presented in a concrete manner.

The sample has shown a slightly higher percentage of 18-20 year old college students performing at the formal operational reasoning level than have other studies targeting similarly selected samples. Studies that are similar in nature have shown as many as 52% of college students tested to still be operating in the concrete stage of cognitive development (Primeau, 1989; Logan, 1991). This study found 31.7% at the concrete level, with an additional 20.0% operating at the transitional level.

Intelligence and its relationship to formal reasoning have been compared in past research, and a moderate relationship has been found to exist (Young, 1993). Young (1993) found a correlation of .58 for the comparison of the ATFR to the WAIS-R Full Scale IQ scores. If this information is coupled with findings that suggest creativity and

intelligence are related (Yong, 1994), then it is important to examine whether a similar relationship exists between creativity and formal reasoning levels. However, the results of this study indicated merely a .16 correlation, or no significant relationship, between the ATFR and the TTCT.

In an effort to determine if gender differences existed in test scores obtained from the participants, the sample group was differentiated on the basis of gender and a series of t tests on mean differences were performed. Statistically significant differences were not found. These results would tend to negate any relationships between differences in scoring to gender differences within the participant pool.

Perhaps the lack of correlation between the ATFR and the TTCT can be explained by individual differences in each of the areas measured by the instruments. Some individuals may be able to score high on both tests, other individuals may score low on both, while others may score high on one and low on the second instrument. Individual preferences may account for some of the variation. For example, if an individual prefers to solve logic problems, he or she may enjoy the challenge of the ATFR, become very involved in the completion of this test, and attempt to do very well on the instrument. If something is worth doing, or if it is enjoyable to individuals, then perhaps their performance will be better than if performing some undesirable task. If being imaginative, and making up creative answers is fun, then perhaps an individual will perform better on the TTCT than on the ATFR.

Yet another potential explanation for the lack of correlation between the ATFR and the TTCT Verbal lies in the fact that these are both generalized measures of the

constructs on which they are based. Gardner's (1985) theory of multiple intelligences suggested seven separate ways in which learning takes place. These seven intelligences are as follows: (a) verbal/linguistic intelligence, (b) logical/mathematical intelligence, (c) visual/spatial intelligence, (d) body/kinesthetic intelligence, (e) musical/rhythmical intelligence, (f) interpersonal intelligence, and (g) intrapersonal intelligence. Gardner suggested that all individuals possess each of these intelligences, but they are not all developed equally. One of the seven is the strongest and the most fully developed. Seven intelligences are provided by Gardner, but it was suggested that several others may exist. The ATFR would perhaps best measure Gardner's logical/mathematical intelligence, while the TTCT would possibly measure visual/spatial intelligence. If Gardner's intelligences are truly distinct, then the lack of correlation between the ATFR and TTCT may potentially be explained partially by this theory. Further research in this area may want to pursue this possibility.

The moderate sample size should be taken into consideration when generalizing the results of this study. Time and financial restraints impacted the number of participants. With larger resources and a larger participant base, perhaps the creativity and formal operational reasoning constructs could be examined using different perspectives.

Although a statistically significant relationship between the ATFR and the TTCT Verbal scores was not found, this study points to a need for further research to examine creativity and formal reasoning. If these two constructs are indeed distinct, then perhaps they are two facets among a greater number of intelligences. Research to determine whether creativity and formal reasoning correlate within a specific area of intelligence.

Investigation into specific areas that are not generalized in such broad terms could prove rewarding. Such research could provide information for educational strategies. If relationships are found, teaching methods could be directed to maximize the potential of each individual learner. In clinical settings, perhaps a client's problem-solving techniques, or lack thereof, could be explored to identify and develop improved problem-solving abilities. In addition, research could further examine the developmental aspects of reasoning, creativity, and giftedness.

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APPENDIX

APPLICATION FOR APPROVAL TO USE HUMAN SUBJECTS

This application should be submitted along with the Informed Consent Document, to the Institutional Review Board for Treatment of Human Subjects, Research and Grants Center, Campus Box 4048.

1. Name of Principal Investigator(s) (Individual(s) administering the procedures):

   Karen L. Hayslett

2. Department Affiliation: Department of Psychology and Special Education

3. Person to whom notification should be sent: Karen L. Hayslett
   Address: 907 Mary, Emporia, KS 66801 Telephone: (316) 342-0187
4. Title of Project: Relationships Between the Arlin Test of Formal Reasoning and the Torrance Test of Creative Thinking

5. Funding Agency (if applicable): N/A
6. Project Purpose(s): The purpose of this study is to determine whether a relationship exists between the Arlin Test of Reasoning and the Torrance Test of Formal Reasoning

7. Describe the proposed subjects: (age, sex, race, or other special characteristics, such as students in a specific class, etc.)

   The proposed participants would be volunteers ranging from age 18 to age 20 that are designated by Emporia State University as freshmen or sophomores. Both genders will be included.

8. Describe how the subjects are to be selected:

   Participants would be selected on a volunteer basis.

9. Describe the proposed procedures in the project. Any proposed experimental activities that are included in evaluation, research, development, demonstration, instruction, study, treatments, debriefing, questionnaires, and similar projects must be described here. Copies of questionnaires, survey instruments, or tests should be attached. (Use additional pages if necessary.)

   This study would be of test results of the Arlin Test of Formal Reasoning and the Torrance Test of Creative Thinking. Participants would be asked to complete the instruments. Directions for administration will be taken from the manuals of each instrument. A brief demographic questionnaire will be filled out by the participants. This questionnaire would be assigned a numerical code to ensure anonymity, as will the instruments. (See the attached sheet.)

10. Will questionnaires, test, or related research instruments not explained in question #9 be used?
    XX Yes _____ No (If yes, attach a copy to this application.)

11. Will electrical or mechanical devices be used? _____ Yes XX No.

12. Do the benefits of the research outweigh the risks to human subjects? XX Yes _____ No

13. Are there any possible emergencies which might arise in utilization of human subjects in this project?
_____ Yes ____XX____ No

14. What provisions will you take for keeping research data private?

The Arlin Test of Formal Reasoning, the Torrance Test of Creative Thinking, and the brief demographic questionnaire will all be assigned numerical codes before being filled out by the participants. Names will not be associated with the test results or demographic questionnaire in any manner.

15. Attach a copy of the informed consent document as it will be used form your subjects.

(See attached sheet.)

STATEMENT OF AGREEMENT: I have acquainted myself with the Federal Regulations and University policy regarding the use o human subjects in research and related activities and will conduct this project in accordance with those requirements. Any changes in procedures will be cleared through the Institutional Review Board for Treatment of Human Subjects.

_____ _____
Signature of Principal Investigator Date

_____ _____
Signature of responsible individual Date
(faculty advisor)

DEMOGRAPHIC INFORMATION

__ __
(Participant Number)

Age: _____

Date of Birth: _____
Month - Day - Year

University Year Designation: Freshman Sophomore
(Circle One)

Gender: Male Female
(Circle One)

Participation Consent Form

Read this consent form. If you have any questions ask the experimenter and s/he will answer the question.

You are invited to participate in a study investigating the relationship between the Arlin Test of Formal Reasoning (ATFR) and the Torrance Test of Creative Thinking (TTCT). The results on each of the instruments will then be compared by the experimenter.

Information obtained in this study will be identified only by code number. Your name will only be used to indicate that you participated in the study and received research participation credit toward the completion of psychology class requirements where applicable.

Your participation in this study is completely voluntary. Should you wish to terminate your participation, you are welcome to do so at any point in the study with no negative consequences. There is no risk or discomfort involved in completing the study.

If you have any questions comments about this study, feel free to ask the experimenter. If you have any additional questions, please contact Karen L. Hayslett, (316) 342-0187.

I, _____, have read the above information and have
(please print name)
decided to participate. I understand that my participation is voluntary and that I may withdraw at any time without prejudice after signing this form should I choose to discontinue participation in this study.

_____ _____
(signature of participant) (date)

THIS PROJECT HAS BEEN REVIEWED BY THE EMPORIA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD FOR TREATMENT OF HUMAN SUBJECTS FOR THE PROTECTION OF HUMAN SUBJECTS

I, Karen Lynn Hayslett, hereby submit this thesis to Emporia State University as partial fulfillment of the requirements for an advanced degree. I agree that the Library of the University may make it available for use in accordance with its regulations governing materials of this type. I further agree that quoting, photocopying, or other reproduction of this document is allowed for private study, scholarship (including teaching) and research purposes of a nonprofit nature. No copying which involves potential financial gain will be allowed without written permission of the author.

Karen Hayslett

Signature of the Author

5/4/97

Date

Relationships Between the Arlin Test of Formal Reasoning and the Torrance Test of Test of Creative Thinking

Title of Thesis

Doug Cooper

Signature of Graduate Office Staff Member

5-5-97

Date Received